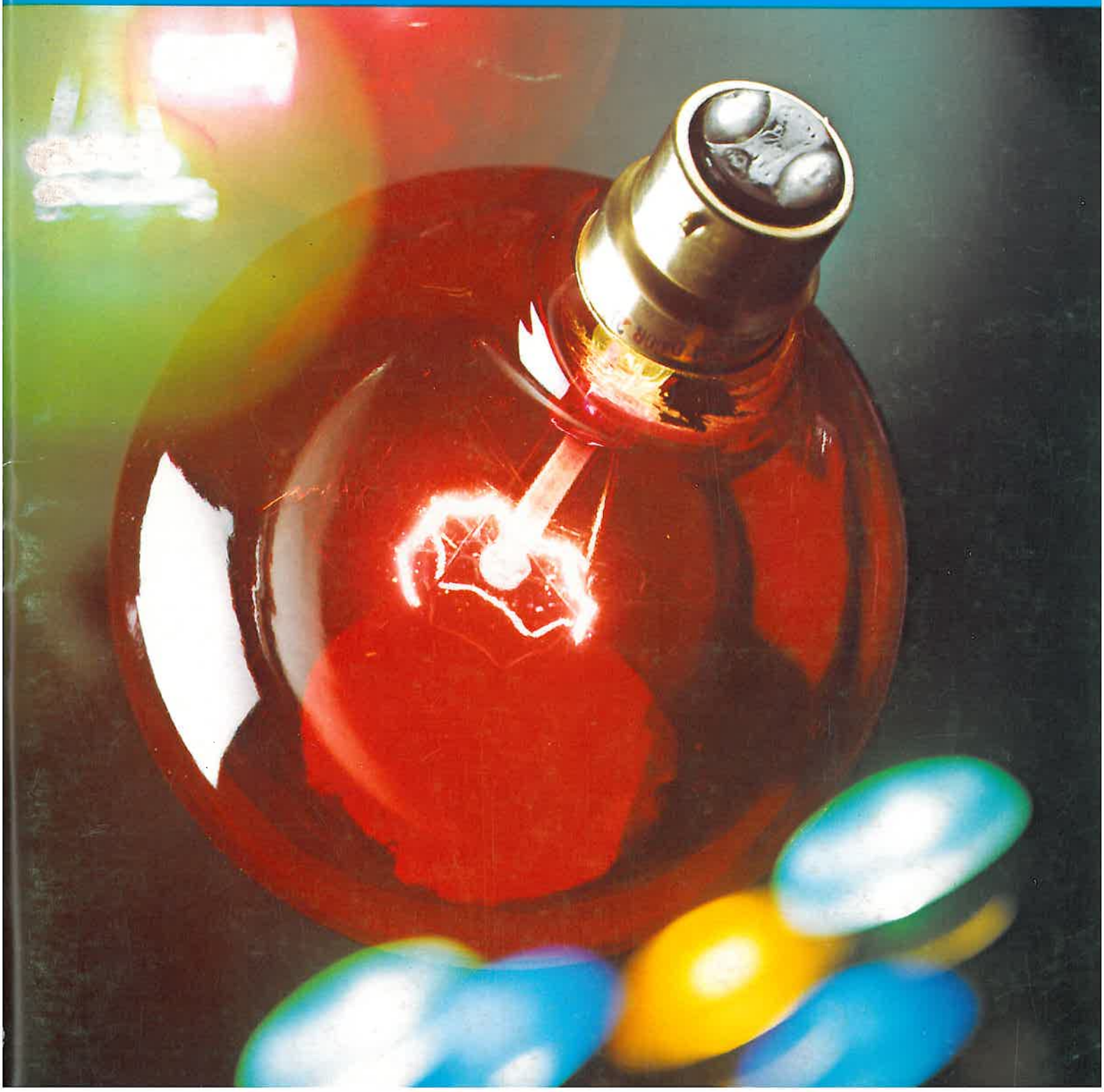
LIGHTING JOURNAL

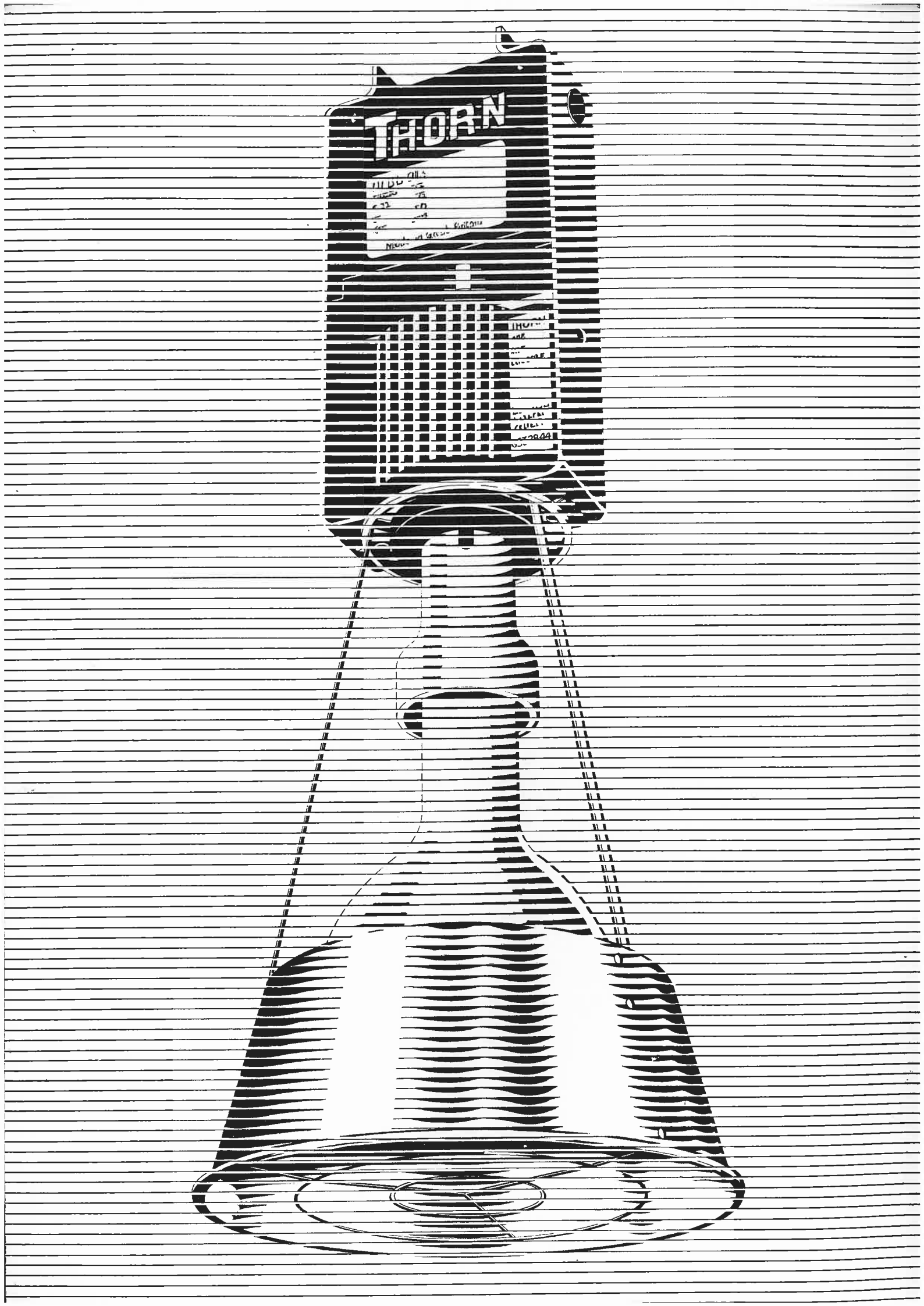
Hipak—a design exercise

Decorative incandescent lamps

Kite-marks and approval marks

number eleven/autumn 1973/published by THORN LIGHTING LIMITED




THORN

LIGHTING JOURNAL

number eleven/autumn 1973

This journal attempts to reflect the technical activities of Thorn Lighting in the fields of lamp research and production, the design and manufacture of luminaires and in lighting practice. Such a picture cannot be presented in a single issue. Indeed, some issues, because they are written around a theme, may seem to be rather one-sided. Taken over the years, however, a fairly coherent portrait of the company should have emerged.

This issue, the eleventh of the series, looks at three main aspects of the company's work. First, it is concerned with the impact of the international outlook encouraged by our entry into the European Economic Community. Articles on the design of a range of industrial fittings for the world market, on international standardisation and illustrations of interesting installations abroad mark this theme.

Another side of the company's activities shown in this issue is the application of lamps and fittings, in which it plays a leading part. The articles describing the relighting of Whitworth Hall and the design of the lighting of the Wick Road Underpass in London, as well as short descriptions of other schemes and a glance at the results of work at Avonbank, Bristol, are of this nature.

Then comes the important aspect of lamp technology. It cannot be too much emphasised that all the progress made in lighting in the last hundred years is entirely due to advances in lamp-making techniques and to improvements in the light output, life and colour-rendering properties of lamps. In this category are the articles on decorative filament lamps and the new MBI lamps for colour printing and we also look at recent developments in electronic dimming techniques.

Next spring we hope to publish articles marking the Jubilee Year of the APLE and on some very interesting lamp developments as well as reporting progress in lighting and manufacturing techniques.

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in diese Ausgabe

6 HIPAK – EINE FORMGEBUNGSUNTERSUCHING. P. G. Harding.

Hochbuchtige Leuchtkörper, die Hochdruck-Entladelampen enthalten, sind schon seit eine Anzahl von Jahren bekannt. Wie die meisten Dinge, die stückweise entwickelt werden, so waren auch diese Leuchtkörper unhandlich und oft schwer zu installieren. Die Entwicklungsingenieure von Thorn Lighting entschlossen sich daher, das Problem neu anzugehen und zu untersuchen, wie die Gestaltung dieser Teile verbessert werden kann.
Im Verlaufe der Durchführbarkeitsstudie wurden interessierte Perteien in der ganzen Welt befragt, und als Folge davon wurden fünf grundlegende Konstruktions-forderungen festgestellt, nämlich: hohe optische Wirksamkeit, einfache und schnelle Installierung und Wartung, Zuverlässigkeit im Betrieb, robuste Bauweise und Erfüllung der nationalen und internationalen Normvorschriften.
Die Leuchtkörper, die als Resultat dieser Untersuchungen hergestellt wurden, weisen einige ungewöhnliche Merkmale auf. Der präzise Einbau der 250 W und 400 W Lampen in einen gemeinsamen Reflektor wurde durch Verwendung eines Distanzstücks ermöglicht,. Hierdurch wurde sowohl die Lichtstreuung als auch der Leuchtenwirkungsgrad verbessert. Verdrahtung und Aufhängungsmethoden wurden vereinfacht. Das Gewicht ist im Vergleich mit früheren Ausführungen bedeutend geringer. Wärme empfindliche Bauteile werden von der Drossel isoliert, so daß die Lampen in einer Umgebungstemperatur von 40°C betrieben werden können. Der Leuchtkörper ist korrosionsfest und entspricht den thermischen Prüfvorschriften von BS 4533. Er wurde nach dem International Protection Code, Standard IP22 getestet und als dieser Vorschrift entsprechend anerkannt. Auf der Hannoverschen Messe erhielt er die Auszeichnung "gute Industrieform 73".

10 VICTORIANA IN NEUEM LICHT. Colin Horsfield.

Die Whitworth Halle, eines der ältesten Gebäude im Komplex der Universität von Manchester, ist ein viktorianischer Bau in gothischem Stil von Waterhouse, der besonders für den Bau des Manchester Rathauses berühmt ist. Wie bei so vielen anderen Bauten jener Zeit, so ergeben sich auch bei diesem erhebliche Beleuchtungsprobleme, teilweise wegen architektonisch bedingter Beschränkungen, teilweise wei der Bau für so verschiedene Zwecke benutzt wird.
Die ursprüngliche Gasbeleuchtung wurde Ende der 30er Jahre durch zehn große achteckige Hängeleuchter mit je einer 300 W und drei 100 W Lampen hinter gefärbten Mattglastafelungen ersetzt. Die Leuchten wurdern paarweise an den Stichbalken des Daches aufgehängt. Die Beleuchtung war aber für die meisten Zwecke ungenügend und wenn die Halle z.B. für Examenszwecke benutzt wurde, so mußten zusätzliche Leuchtstoffröhren an den Bundbalken aufgehängt werden.
Als man sich dazu entschloß, die Halle zu reinigen und die Beleuchtung zu verbessern, arbeitete ein Team von der Universität unter Führung von Dr. James Bell in enger Zusammenarbeit mit den Ingenieuren von Thorn Lighting und als Resultat wurde ein Schema ausgearbeitet, bei dem die Hauptbeleuchtung von verschiedenartigen Scheinwerfern ausging, die sich zwischen den Trägern des kunstvoll ausgearbeiten Holzdaches angebracht wurden. Zehn antike Gaskronleuchter wurden an die Stichbalken angehängt, um "Glanz und Atmosphäre" zu verbeiten.
Das hauptsächliche "Arbeitslicht" für Examen und ähnlichen Funktionen ging von sechs 1000 W Wolfram-Halogenlampen aus, die in obenliegenden Reflektoren direkt unter dem Dachfirst angebracht waren, während die allgemeine – mesitens indirekte – Beleuchtung von 300 W PAR 56 Lampen abgegeben wurde, die etwas unterhalb der Stichbalken montiert waren, sowie von 500 W "Sunflood"-Lampen, die von einer darunterliegenden Stelle aus Wände und Decke anstrahlten. Auf diese Weise wurde zu gleicher Zeit eine geringere Beschattung der Decke und eine bessere Hervorhebung der Balken erzielt.
Fensteraussparungen, in denen Porträts an Eichen – Täfelungen aufgehängt waren, erhalten eine besondere Beleuchtung von einer 50 W Leuchtstoffröhre, die ein warmes weißes Licht abgibt. Die Fassungen der Röhren sind "Arrowslim"-Leuchtkörper, deren metallische Schutzschirme mit einer zur Täfelung passenden Farbe angestrichen sind.
Jederder zehn schmiedeeisernen Gaskronleuchter, die anstelle der achteckigen Hängeleuchter getreten sind, ist mit achtzehn 24 V, 12 W klaren Schienenlampen ausgerüstet und ungefähr an den gleichen Stellen angebracht, die früher von den Gasstrahlern eingenommen wurden. Der längeren Nutzdauer wegen sind sie etwas unterfahren. In den Sockel jeder der Hängeleuchten ist ein 150 W PAR 38 Flutlicht eingebaut, das sein Licht nach oben wirft und die vergoldeten Verzierungen hervorhebt.
Aus den Fotografien ist ersichtlich, wie erfolgreich das Schema war. Es ist ein eklatantes Beispiel für die guten Resultate, die sich erzielen lassen, wenn Architekt und Beleuchtungsingenieur von Anfang an zusammen arbeiten.

14 ELEKTRONISCHE VERDUNKELUNGSSYSTEME. B. Massey, und I. J. Bramson.

Dimmerschaltungen wurden zuerst in den Pioniertagen der elektrischen Beleuchtungstechnik agnewandt, als es notwendig war, im Theater eine Alternative zum Niederdrehen des Gases zu finden. Für die damals verfugbaren Gleichstromanlagen benutzte man schwerfällige, drahtumwickelte Rheostate und "Wasser-Dimmer". Anfangs der 30er Jahre ermöglichten die Wechselstromnetze eine bessere Steuerung, aber die Regeltrafos und sättungsfähigen Drosseln waren immer noch sehr sperrig. Erst kurz vor Kriegsausbruch wurde mit der Einführung der Thyratronröhre der Weg zu einer elektronischen Steuerung beschritten.
Seit jener Zeit haben Festkörperelemente mit "Thyristoren" und "Triacs" es möglich gemacht, unglaublich kompakte Geräte mit vernachlässigbaren Leistungsverlusten für diese Zwecke einzusetzen.
Wenn auch der Einsatz von großen Anladung zunächst noch auf die Bühne und das Fernsehstudio beschränkt ist, so finden doch die heutigen methoden der Verdunklung überall dort Anwendung, wo künstliches Licht verwendet wird. Diese Methoden kommen sowohl für Wolframdraht- als auch für Leuchtstofflampen in Frage.
Kleine Lichtsteuergeräte, mit Reihen von zwei oder mehr "Blenden" sind für die Amateurbühne verfugbar, und in manchen Fällen ist sowohl eine handbetätigte als auch eine automatische Steuerung möglich. Das Licht läßt sich wie benötigt auf- und abblenden, und es kann der Musik entsprechend pulsiert werden oder automatisch die Farbe wechseln, wenn dies angebracht ist. Außerdem sind Speichersysteme erhältlich, in denen ganze Beleuchtungssysteme in einem "elektronischen Hirn" gespeichert und zum richtigen Zeitpunkt eingeschaltet werden. Für große Bühnen und Fernsehstudios werden jetzt Systeme wie z.B. Thorn Q-file und Q-Master benutzt die bis zu 200 Speicher in einem kleinen Schrank vereinen.
Elektronische Verdunkelung wird jetzt auch für viele verschiedene Beleuchtungseinrichtungen verwendet – von Gemäldegalerien bis zu Hospitälern, von Läden bis zu Tunneln und Unterführungen. Organisationen wie die Thorn Theatre Lighting Division erteilen gern Informationen hierüber.

23 BELEUCHTUNG DER WICK ROAD UNTERFÜHRUNG IN LONDON.

Diese vor kurzem fertiggestellte Unterführung besteht aus einem 152 m langen dreibahnigen Kurventunnel. Zwei durchlaufende Leuchtstoffsimse erzeugen eine durchschnittliche Beleuchtungsstärke von 250 Lux am Tage und 56 Lux bei Nacht, wenn die Hälfte der Lampen erloschen ist.
Thorn Kolorson (SON/T) Lampen in speziell gestalteten Reflektoren verstärken die Beleuchtung am Eingang jan einem hellen Tag zu 3000 Lux. Die Abschwächung erfolgt in zwei Stufen von 2000 Lux und 1100 Lux auf Grundniveau. Am Tage, wenn die äußere Beleuchtungsstärke weniger als 20 000 Lux beträgt, wird die Hälfte der Lampen während der ersten Stufe durch ein fotoelektrisches Element gelöscht.
Im ersten, 50 m langen Abschnitt des Tunnels wurden im Beton im Abstand von 1.50 m schräge Rinnen geformt in denen zwei 400 W SON/T Lampen in Parabolreflektoren angebracht sind. Sie sind dem Eingang zugeneigt und erzeugen auf Straßenniveau eine gesamte Beleuchtungsstärke von 3000 Lux. Im zweiten 50 m Abschnitt ist der Abstand auf 3 m erweitert und die Beleuchtungsstärke auf 2000 Lux reduziert. Im dritten Abschnitt werden 250 W SON Lampen verwendet, die die Leuchtstärke auf 1100 Lux herabbringen.
Die Leuchten wurden von Ingenieuren der Electrical Services Division des Department von Architecture and Civic Design des Greater London Council konstruiert, von Thorn Lighting Ltd. hergestellt und von Green and Silleyweir Ltd. installiert.

25 LAMPENDESIGN FÜR DEKORATIVE ZWECKE. Dr. G. E. Coxon.

Effektlampen, die hauptsächlich als Verzierung und erst in zweiter Linie als Lichtquelle dienen, traten innerhalb weniger Jahre, nachdem Swan und Edison Original-Kohlefadenlampen auf den Markt kamen, in Erscheinung. Einige hatten farbige oder ungewöhnlich geformte Birnen, andere imitierten frühere Beleuchtungsmethoden wie z.B. Kerzen.
Als man begann, Metallfäden zu benutzen, behaupteten sich diese besonderen Arten von Lampen und dazu kamen noch rohrförmige Fadenlampen, die zwischen den beiden Weltkriegen auf dem Markt erschinen. Diese Lampen werden immer noch für Juweliervitrinen benutzt.
Seit einiger Zeit wird erneut Interesse für Lampen als Ziergegenstände gezeigt, mit dem Resultat, daß das Designproblem insofern neu angegangen wurde, als man sich jetzt auf die Methoden der Mengenproduktion stützte. Dabei ergaben sich für die Fabrikation einige Einschränkungen, insbesondere war es nunmehr notwendig, Lackfarben auf die Glasoberflächen aufzutragen anstatt die Birnen aus farbigem Glas zu blasen.
Die Nachfrage nach innerer Versilberung – sowohl von Reflektorlampen aus geblasenem Glas als auch die Arten der Kronversilberung – wird ständig größer, und auch die Innenbeschichtung mit Kieselerde ist populär. Lackfarben müssen auf das Glas aufgebrannt werden und bei diesem Herstellungprozeß ist eine strenge Temperaturkontrolle unerläßlich. Diese Art von Überzug kann auch die Betriebstemperatur der Lampe beeinflussen. Eine neuere Entwicklung ist die Verwendung von Zweifarbenfiltern für Farbscheiben und "Kaltspiegel".
Der Trend zu den neuen Formen und Farben der Zierlampen widerspiegelt die Ideen der Vergangenheit. Die Verwendung von neuen Materialien und Methoden zeigen, daß selbst nach 100 Jahren Fortschritt in her Beleuchtungstechnik die Ideen der Vergangenheit im Geiste des Publikums immer noch lebendig sind.

29 DRACHEN-MARKEN UND GUTBEFUNDZEICHEN. R. C. Kember, J. E. Greenhill and L. H. Da Volls.

Behördliche Gutbefundzeichen werden auf dem europäischen Kontinent viel angewandt. Sie schützen den Kunden gegen unbefriedigende oder unsichere Erzeugnisse und sorgen dafür, daß die angebotenen Waren einen anerkannten Gütegrad aufweisen.
Derartige Prüfungen werden in Großbritannien schon seit langem auf einer freiwilligen Grundlage ausgeführt. Zur Zeit gibt es eine ganze Reihe von Gutbefundzeichen. Im Februar dieses Jahres erließ der EWG-Rat eine wichtige Direktive, die allgemein unter dem Namen Niederspannungsdirektive bekannt ist und mit der bezweckt wird, die Sicherheitsregulierungen in den angeschlossenen Ländern zu harmonisieren, um dadurch den Handel zwischen den Ländern zu erleichtern. Die Direktive besteht aus einer Einleitung und 14 Bestimmungen, von denen die dreizehnte besagt, daß die Mitgliedsländer innerhalb von 18 Monaten ab Erlaß der Bestimmung diesbezügliche Schritte unternehmen müssen.
Vor kurzem wurde eine neue britische Normvorschrift für Beleuchtungskörper – die Vorschrift BS 4533 – erlassen und gleichzeitig führten die Lighting Industry Federation und die British Standards Institution eine "Drachen"-Markierung ein. Die Marke bedeutet nicht nur, daß der betreffende Artikel durch Testen der einzelnen Leuchten gutbefunden wurde, sondern auch, daß die Herstellerfirmen ihre Prüfeinrichtungen auf dem vom BSI verlangten Standard halten müssen und daß ihre Fabrik regelmäßig inspiziert wird.
Die Klassifizierung von Befestigungsflächen ist in Aussicht genommen und wird wahrscheinlich auf einer internationalen Basis erfolgen. Die Befestigungsflächen werden wahrscheinlich in drei Gruppen eingeteilt: unverbrennbare, normal brennbare und leicht brennbare. Beleuchtungskörper sollten nicht an Befestigungflächen der letzteren Kategorie montiert werden.
Eine kürzliche Entwicklung in Deutschland befaßt sich mit der Überhitzung des Vorwiderstands in einer Leuchte am Ende der Nutzdauer sowie mit der Gefahr, daß die Fläche, an welcher die Leuchte befestigt ist, Feuer fangen kann. Die deutsche Lösung des Problems besteht darin, den Vorwiderstand in einem Abstand von der Leuchte, und die Leuchte in einem Abstand von der Befestigungsfläche zu halten. Solche art konstruierte Leuchten erhalten die "F"-Marke – ein großes F, eingeschlossen in einem umgekehrten Dreieck. Amerikanische Ingenieure verwenden Ausschalter, die in Funktion treten, sobald die Temperatur des Kontrollgeräts einen gefährlich hohen Stand erreicht.
Die Bemühungen, nationale Sicherheitsnormen in Übereinstimmung zu bringen, so daß eine vollkommen einheitliche europäische Norm geschaffen wird, sind weit fortgeschritten und man hofft, daß dies zur Schaffung von weltweit gültigen Normen führen wird. Was die Auferlegung freiwilliger Normen anbelangt, so ist Großbritannien führend, und wir haben unseren Partnern in der EWG diesbezüglich viel zu bieten.

32 HALEGONIDLAMPEN FÜR DAS GRAPHISCHE GEWERBE. A. L. Salway, and E. J. G. Beeson.

Die Klischeeherstellung für gas graphische Gewerbe ist ein großes Geschäft. Es handelt sich hier um ein fotografisches Verfahren, bei dem eine Lichtquelle mitstark ultraviolettem Spektrum benutzt werden muß. Viele Jahre lang wurden dazu Kohlebogenlampen benutzt, die aber jetzt durch andere Lichtquellen, besonders durch pulsierte Xenonbogen, ersetzt werden. U.V. emittierende Leuchtröhren wurden verwendet, aber die Notwendigkeit, mehrere Röhren zu benutzen, um auf die erfoderliche Lichtstärke zu kommen, hat den Nachteil des "Unterschneidens" der bei Verwendung einer Punktquelle nicht in Erscheinung tritt.
Kürzlich eingeführte Halegonid-Entladungslampen haben dazu gefuhrt, daß in einigen großen Druckereien 1200 W Linearquellen benutzt werden. Insbesondere werden diese Lampen zur Verwendung für das "Gevaproof"-System von Agfa Gevaert standardisiert. Die 1200 W MBIL Lampe ist jedoch für kleinere Druckereibetriebe zu groß und hat einige technische Nachteile.
Jetzt wurde eine in eine PAR 64 Hülle eingeschmolzene 400 W MBIL Lampe entwickelt, die verschiedene Vorteile hat. Der genau voreingestellte Strahl gibt über eine rechteckige Fläche von der durchschnittlichen Größe eines Kopierrahmens eine einigermaßen gleichmäßige Strahlung. Diese Lampe läßt sich leicht anstelle eines Kohlebogens einsetzen, wenn sie in einem speziell konstruierten Leuchtkörper montiert ist, der mit magnetisch betätigter Blende versehen ist und Steuer – und Startgeräte enthält. Diese Anwendung von UV für Druckverfahrer ist bezeichnend für das wachsende Interesse an UV-Quellen für weitere Einsatzgebiete, ein Umstand, dem in den Forschungs – und Entwicklungslaboratorein von Thorn die gebührende Aufmerksamkeit geschenkt wird.

36 AVONBANK – EIN JAHR ERFAHRUNG.

(Lighting Design and Technology, Vol. 5, No. 2 1973). Die geregelte Umwelt in Avonbank – die Büros von South Western Electricity Boards in Bristol – wurden in Ausgabe 7 von *Lighting Journal* beschrieben. Seitdem ist über ein Jahr vergangen und ein auf einer gemeinsamen Sitzung von IES und der Building Services Engineering Society gehaltener Vortrag beschäftigtsich mit den Ergebnissen.
Einer der interessantesten Punkte, die sich aus dieser Studie ergeben, sind die Reaktionen der Leute, die in den Büros unter den neuen Umständen arbeiten. Dieses Personal wurde aufgefordert, einen Fragebogen auszufüllen, bevor es von herkömmlichen Büros nach Avonbank kam, und dann wieder, nachdem es 4 Monate lang dort gearbeitet hatte. Die Antworten werden in graphischer Form gezeigt.
Dieses Material wird mit Genehmigung der Verfasser – Mr. M. Wood-Robinson und Mr. Ian Crichton – sowie der IES, in dessen "Transactions" es bereits veröffentlicht wurde, wiedergegeben.

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Hipak - a design exercise

by P G Harding

Like most things which have been developed piecemeal, the majority of high-bay fittings, although robust and giving excellent light control, are frequently heavy, difficult to install, costly and somewhat clumsy in appearance. Thorn Lighting engineers and designers decided to look at them afresh to see how their design could be improved.

Thorn Lighting is an international company and from the outset it was appreciated that the total market was the world, not the UK with Europe. Therefore to assist us in our research at the concept stage we approached interested parties, including practising engineers, throughout the world.

Four basic design requirements were eventually established:

1) High optical efficiency;
2) Simple, quick installation and maintenance;
3) Tough construction and reliable operation;
4) Compliance with national specifications.

OPTICAL DESIGN

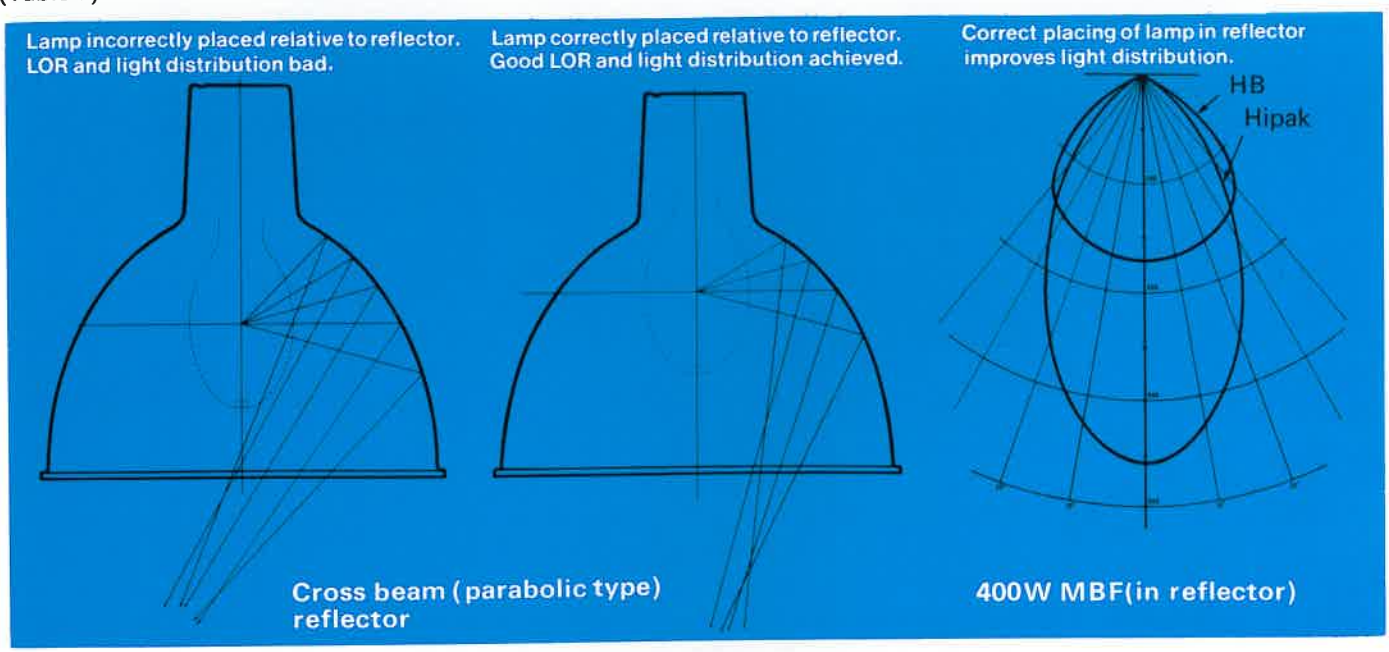
A luminaire is of little value if, due to poor optical design, it is unable to provide light of the desired intensity where it is required. If the maximum light output and control is to be achieved, the centre of the discharge column within the lamp must be at the focal point of a correctly designed reflector. Since the 250W and 400W elliptical lamps are of different sizes, to produce the maximum light output would require two reflectors, but from an economic point of view this is obviously not viable.

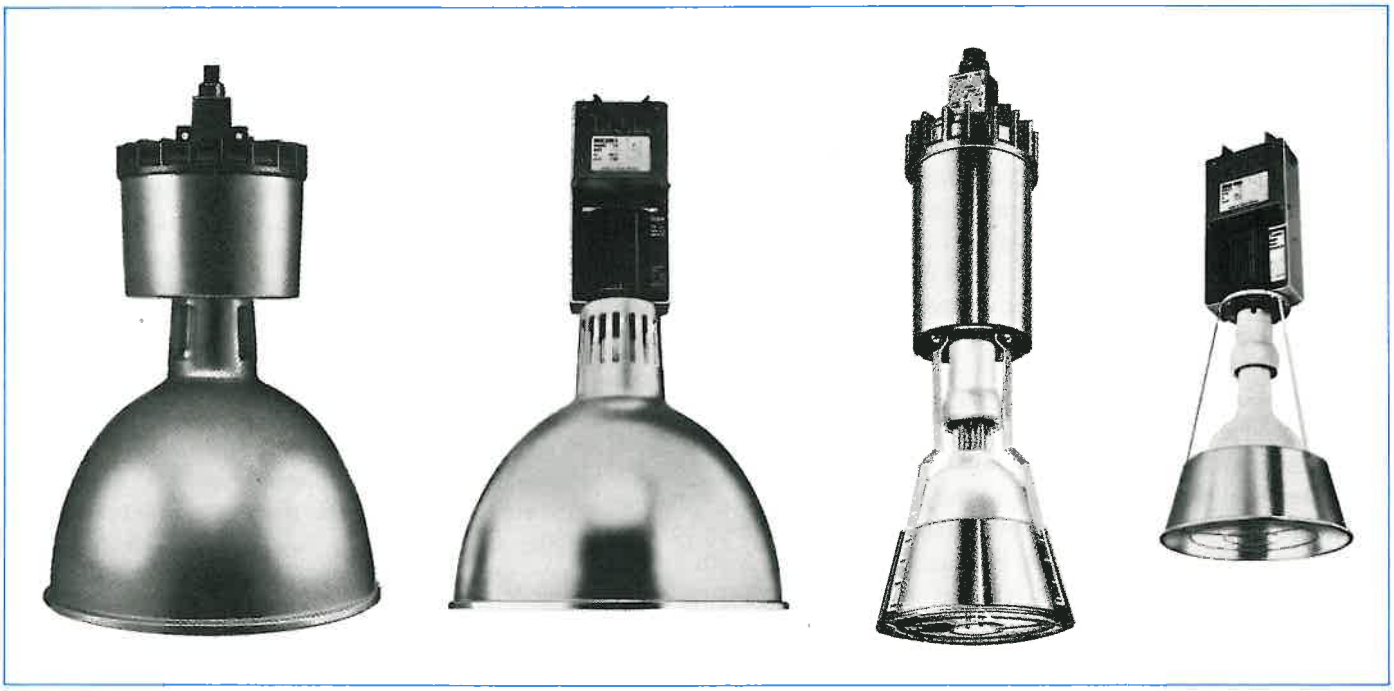
In the past a compromise was made, with the result that neither lamp was in the optimum position. Now the parabolic reflector for elliptical lamps has been redesigned and, by the introduction of a lamp-spacer fitted between the outer frame and lampholder, a significant improvement has been achieved. Two lamp-spacers, one for each type of lamp, position the light-centre of the lamp accurately relative to the reflector, for both lamp sizes. Accurate placing of the reflector improves the light output ratio and light distribution of the fitting (Table 1).

	LOR %		Lighting design Lumens
	Old fitting	Atlas Hipak	
250W MBFR	89	92	10 500
400W MBIF	76	87	27 000
400W SON	77	80	40 000

Table 1 LOR comparison

P G Harding is Product Executive for Industrial Luminaires, Thorn Lighting.





Old and new types compared. The Hipak fittings are on the right of each pair.

The reflector is made from spun aluminium. It is chemically brightened and anodised. To avoid fatigue problems around the reflector suspension points, a plated steel reinforcing plate is introduced at the neck of the reflector which has been enlarged in diameter to permit greater accessibility.

Where reflector lamps are used a spun aluminium skirt takes the place of the reflector. This, too, has been simplified in design and is easily positioned by means of keyhole slots.

INSTALLATION

A fitting which presents difficulties during installation – such as an inaccessible terminal block – will take much longer to install than one which is straightforward. The hidden cost this represents is sometimes not appreciated until the final bill is presented. The installing electrician should not be forgotten either. He may be 8m above the ground, perhaps in an inaccessible position, and his task becomes even harder if fittings are heavy and present wiring or suspension difficulties. Fittings designed with easy installation in mind bring benefits to the user in financial terms and in the standard of the final work.

In the Atlas Hipak fitting the wiring box is large and there are no parts to drop. A large terminal block, capable of taking 4mm^2 looped cable, is provided. A variety of cable types may be used, seals being effected by glands or conduit, and there are suspension points for flexible or tube drop methods. Weight reductions ranging from 10-53% have been achieved (Table 2) mainly by the sensible choice of materials and the use of ignitor circuitry for the high pressure sodium or metal halide lamps.

RELIABLE OPERATION

Prolonged, reliable service is expected of these luminaires which are often infrequently maintained even where environmental conditions are severe. Warm humid atmospheres, perhaps carrying airborne dusts or corrosive agents, are not unrepresentative of the more extreme conditions encountered. Mechanical stress is also often present; a typical source of such stress, found in many industrial premises, is a travelling gantry crane. Unless the luminaires are designed to resist the vibrations of the structure produced by the motion of the gantry, premature component failure could result.

If the fitting has not been designed for prolonged operation in the areas where it will find most use, it will fail. The two major problem areas for the designer to tackle are thermal and mechanical.

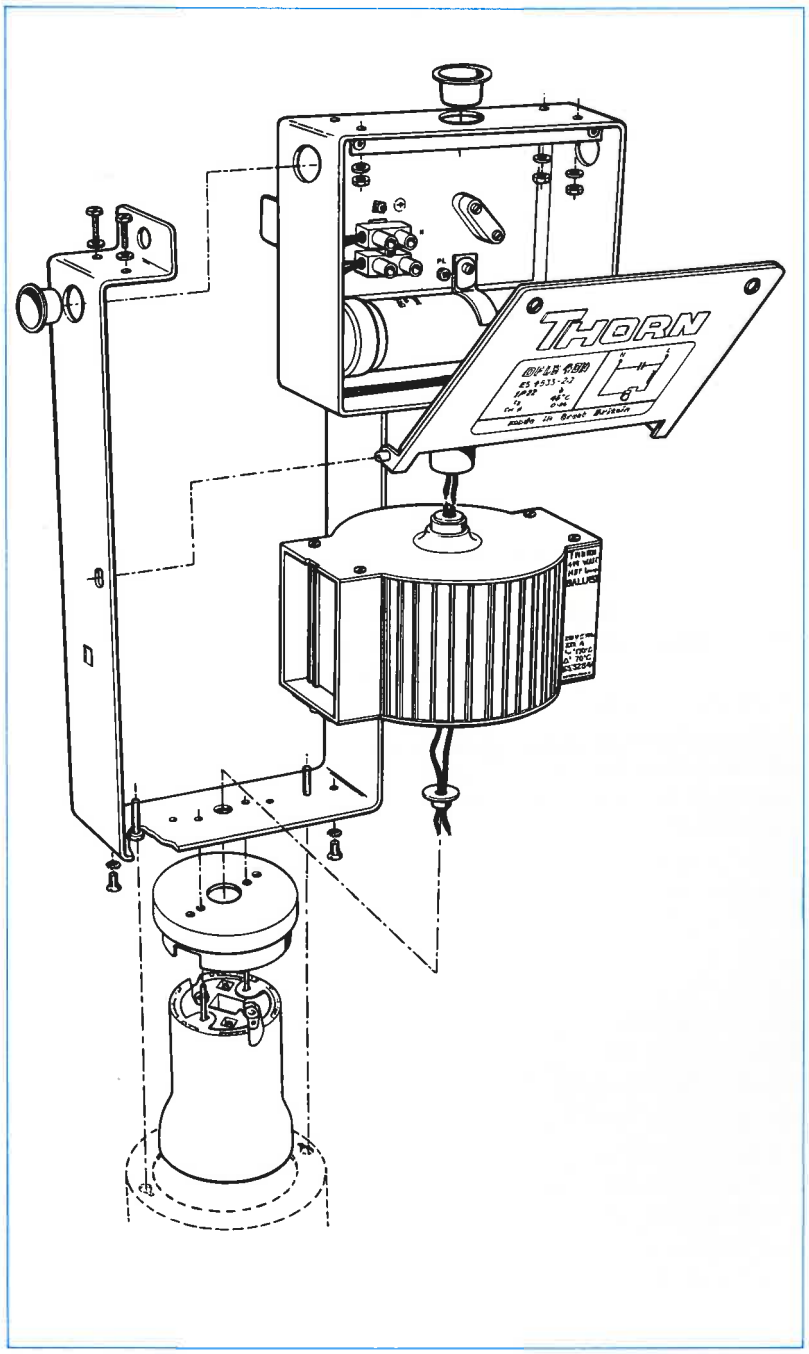
Fitting	Approximate weight (kg)		Approximate decrease
	HB range	Hipak	
250W MBFR	7.00	6.30	10%
400W MBFR	9.20	7.20	21.5%
250W MBF	8.60	7.25	15.5%
400W MBF	10.50	8.15	24%
250W SON	13.60	9.15	32%
400W SON	15.40	10.25	33.5%
400W MBI	18.40	8.55	53%

Table 2

Heat considerations

Next to the lamp itself, the hottest component in a discharge circuit is the ballast. The heat generated in operation could adversely affect the performance and ultimate life of other components such as capacitors. From market research it was established that many areas where high-bay fittings were used could reach ambient temperatures in excess of 40°C. To achieve satisfactory operation in these very warm conditions prototypes were built and tests were run on a number of designs. Finally, it was decided to encapsulate a precision wound ballast into an aluminium extrusion. The extrusion was designed to accommodate ballasts for both high pressure sodium and mercury as well as metal halide lamps within its section.

Vertically finned and finished matt black, the ballast unit has proved most efficient at dispersing internally generated heat, while, since the same extrusion is used to house different types of gear, only one production tool is required. Because the ballast was a self-contained unit it was possible to place the other temperature-sensitive components away from its immediate vicinity, so allowing them to run within their thermal limits. The terminal block and capacitor – and



Exploded view of Hipak components. The capacitor and connecting box are separated from the ballast in its finned aluminium housing. The thickness of the spacers between frame and lampholder is varied to suit the size of lamp.

ignitor when required – were housed together in one box, fitting neatly into the outer frame and separated from the ballast by an air gap; heat-transfer from this component was thus minimised.

Strength and resistance to corrosion

Careful consideration was given to the constructional materials. As previously described, the ballast is encapsulated in an aluminium extrusion. Aluminium has satisfactory corrosion-resistant properties in most atmospheres but, as a further precaution, the extrusion has been painted with a black matt-finish paint. For fittings using mercury vapour circuitry the wiring box is made of injection moulded polycarbonate which has excellent corrosion-resistant properties, is very tough, and is the material from which vandal-proof bowls for street lighting lanterns are manufactured. Fittings with circuitry for metal halide and high-pressure sodium sources use a stove enamel steel wiring box, the lids being common with the mercury fluorescent type, gasketted with close-cell neoprene and made from polycarbonate. The outer frame is fabricated from steel, galvanised and painted with a grey stove-enamelled paint. The components are held together by stainless steel screws. These measures ensure that the fittings can withstand most environmental conditions, even those as formidable as are found in steel mills where not only are all the 'corrosion evils' present but, because the fittings are often mounted in inaccessible positions, maintenance can be difficult.

COMPLIANCE WITH SPECIFICATIONS

Many countries, including Germany and Sweden, discourage the internal sale of fittings unless tests are conducted by and approval gained from their own national test houses. The differing requirements of these countries were taken into account at the design stage and Hipak has therefore not only been designed, manufactured and tested to BS 4533 – the new British Standard for lighting fittings – but to meet international market conditions.

Thermal testing to BS 4533 is particularly onerous. Components must all operate within their thermal limitations at a voltage rated 10% above normal and for the UK this means running them at 264V compared with 240V. Under these conditions components become unusually warm and against this background it is even more remarkable that Hipak has been rated as suitable for operation in ambient temperatures of 45°C.

Because they are likely to be used in semi-sheltered outdoor locations, the fittings have also been tested and approved to IP22, that is, they are rated as drip-proof. The IP code is the International Protection Code and is widely used and understood as signifying an agreed standard of protection.

Conclusion

Industrial design is a process from which frustration, repeated revision and compromise is seldom absent. The designer must satisfy the design parameters in full while maintaining an awareness and an appreciation of both the cost targets and the production methods at his disposal. He must not isolate himself from the opinions of his colleagues, the development and production engineers. Yet from him we demand originality and flair. It is a challenge indeed, and the illustrations clearly show how well the designer, Colin Dipper, Dip.A.D., L.S.I.A., succeeded in meeting it.

Hipak has a strong visual identity, the emphasis being placed on function. By a bold design approach many of the problems inherent with this type of fitting – such as heat, installation difficulties and corrosion – have been successfully overcome. All the requirements needed to satisfy the demands of an international market have been met – as the presentation of a design award (Die Gute Industrieform 1973) at the Hanover Trade Fair this year demonstrates.

Victoriana relighted

by Colin Horsfield B Tech

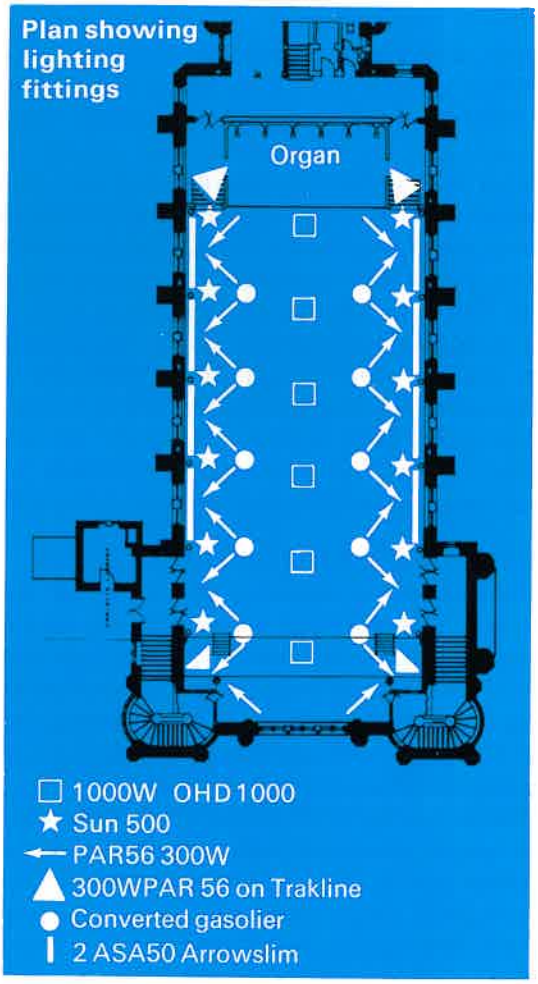
The Whitworth Hall, one of the oldest buildings of Manchester University, is a distinguished Victorian high gothic structure designed by Waterhouse, the architect of Manchester Town Hall. Built of white stone, with an elaborate hammer-beam roof, it is panelled in oak to the level of the window-sills, and portraits of chancellors and benefactors of the university are hung around the walls. The platform end is completely filled by an enormous pipe organ and the general effect is something between Middle Temple Hall and a large methodist church.

Such buildings are to be found all over the country and they present a difficult lighting problem. They are of sufficiently strong architectural character to merit careful treatment but they are used for such a variety of purposes that their lighting must often be functional as well as decorative. Unlike the halls of medieval colleges, which it so closely resembles, the one thing the Whitworth Hall is not used for is eating. It is the scene of numerous activities ranging from orchestral or choral concerts to school prize-givings; it is used for lectures, dances and social functions and as well as being the scene of the bestowal of degrees it is one of the chief examination rooms of the University. Nearly all these functions take place in the afternoon or evening so that the great majority of them are held under artificial light. Consequently, the lighting scheme provided must not only be keyed in to a very distinctive architectural setting but also be extremely versatile in use: able to provide a high level of general illumination in some circumstances, in others to produce a restful atmosphere and in yet others a dramatic one.

The oak ceiling and panelling were originally stained dark brown and the hall, which must have been lit by gas when it was first built, was relighted in the 1930s by a system of large hexagonal pendants, vaguely gothic in shape, housing filament lamps behind white opal glass panels. These were hung from the ends of the hammer beams; each housed one 750W and three 200W lamps and the maximum illumination achieved was in the order of 100 lux. Walls and ceiling and most of the vast organ case were lost in gloom and the general effect was heavy and depressing. When the room was used for examinations the inadequate illumination was augmented by the light from fluorescent batten fittings hung from the tie bars.

When it was decided to clean and restore the hall, it was seen that the lighting system must be improved as well. The University Building Team decided that the visual effect of the original gas pendants ought to be reproduced, but that the working light must come from modern equipment, concealed as far as possible in the elaborate roof. They found the perfect answer to the initial problem in a set of wrought-iron gasoliers of almost exactly the same date as the building—they came from a redundant local church—and these, suitably converted, were hung from the hammer beams in the original positions. They contribute little or nothing to the general illumination level and are regarded purely as decorative and atmospheric.

The basic lighting systems were worked out by Thorn Lighting engineers in close collaboration with the University Team. An experimental installation was set up in the front two bays to determine mounting positions and beam patterns and it was decided at this stage that all general light sources should be incandescent lamps as none of the discharge lamps tried provided the correct colour rendition of the cleaned stone and woodwork. This decision proved



The Whitworth Hall seen (above) from the platform and (right) as the audience sees it. Lamps on the hammerbeams are shielded from view.

fortunate, when, at a later stage, it was decided to put the powerful overhead lights employed when the room was used for examinations on dimmer control.

The final scheme resolved itself into three main sections, each providing light of a different character to suit different uses of the hall. For its use as an examination room functional lighting had to be provided; for general purposes a system of floodlighting the walls and ceiling was evolved; and for the more dramatic effects required at social functions and dances a system of picture lighting combined with the decorative pendants is installed. Each section can be used independently or in conjunction with the others.

The lighting of the central area presented few difficulties. For this purpose six 1 000W tungsten-halogen lamps were mounted in OHD reflectors in the apex of the roof; they give an illuminance of 300 lux at table level. Although these fittings tend to give strong modelling when operated alone, the effect is softened by other sources.

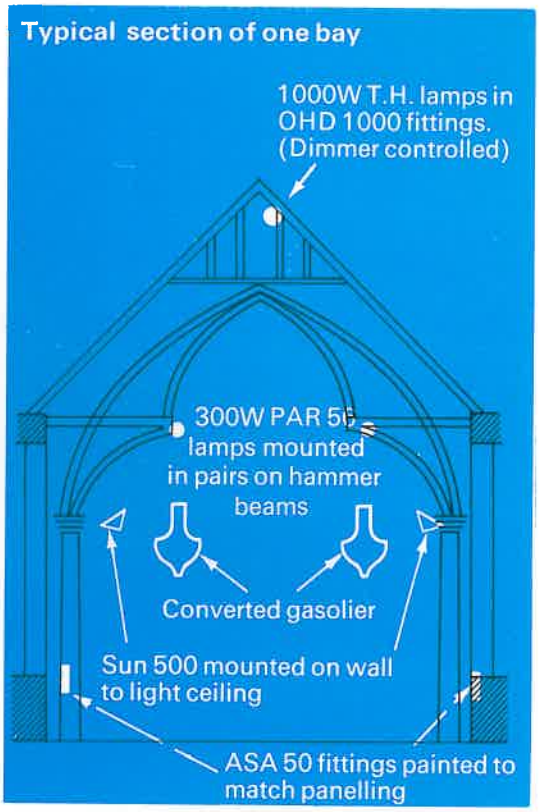
The general lighting is mainly indirect, that is to say the effect is achieved by directing the light on the walls and ceiling, although there is a certain amount of spill-light from the 300W PAR 56 lamps mounted on the hammer beams, which is valuable in providing some directional modelling.

The roof was lighted by 500W tungsten-halogen Sunfloods mounted on the capitals of the free-standing shafts between the windows; the fittings were inverted and set to an angle so that there is minimum reflector shine to a person standing on the far side of the hall. These fittings floodlight the roof and upper areas of the walls on both sides of the hall. By mounting the Sunfloods under the beams, minimum shadowing of the ceiling and improved modelling of the beams themselves were achieved.

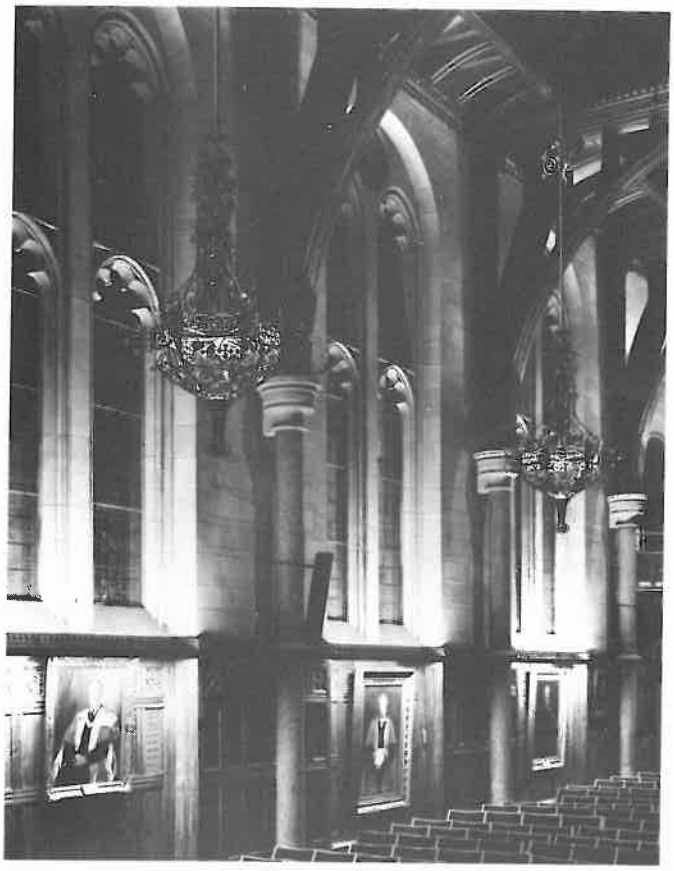
The middle parts of the walls were floodlit by PAR 56 fittings mounted towards the end of the hammer beams; 300 watt wide-beam PAR 56 lamps were cross-projected in each bay, the major axis of the beam being orientated vertically and the spotlights aimed towards the mullions of the windows. Care was taken that bright images of the apertures in the beams were not projected on to the adjacent bay, and to eliminate dark patches in the central parts of the wall in the bays where there are no windows. This was achieved on completion of the installation by accurate alignment of each fitting. It was then found necessary to incorporate spill rings on to those fittings shining rearwards since, although they are mounted at a height of considerably over 30ft, there was some discomfort from the bright image of the edge of the lamps.

The lower area behind the stage is wood-panelled while the part above is covered by an array of organ pipes. PAR 56 lamps with medium beam patterns were employed. They are carried on an 8ft length of Atlas Trakline mounted vertically at the edge of the first hammer beam, and the beam patterns of the lamps are orientated horizontally working down the wall to the stage below. The light is cross-projected from either side and the modelling of the features is good, with strong high-light and shine from the organ pipes. The faces of people standing at the front edge of the stage are, perhaps, too strongly modelled when only the stage lights are in operation, but this is softened when the general hall lights are in use. If the floodlights had been taken back to the next beam, the modelling would have been softened, but the glare at the speaker's position would have been increased, and the problem of shadows cast by the first hammer beam on to the front wall would have become significant.

The rear wall is treated in a similar manner but with only three floodlights on each side. These are directed towards the mullions of the large rear window; two wide beams are orientated vertically and one medium beam is directed horizontally on to the lower sill. The flood-



Converted gasolier



lights are cross-projected and give good modelling of the stonework. The first four bays of the hall have windows and window seats. The existing lighting consisted of strip lights above the pictures, but it was felt that an increased luminance on the inside of this area, especially on the inside edges of the window mullions to complement the highlighted areas above, would be worth while. The effect is achieved by mounting two ASA 50 Arrowslim fittings butted end-to-end in each window embrasure, the front baffles being painted to match the panelling. The upward light from these illuminates the lower areas of the window and the downward light illuminates the pictures and the upper area of the panelling. The colour and brightness of the fluorescent tubes was carefully selected, and in the end 5ft 50W warm whites were determined to be most appropriate but with eight inches of the outer ends of the tubes blacked off. To reduce the specular reflections on the oak panelling the lower half of the front baffle was painted black.

Each of the antique wrought iron gasoliers which replaced the original hexagonal pendants was equipped with eighteen 24V 12W clear bus lamps mounted in the positions of the original gas jets and slightly under-run to assume a reasonable life. A 150W PAR 38 floodlamp was mounted in the base of each pendant so that its light shone upwards and highlighted the gilded parts of the wrought iron. These lamps can be switched separately if required.

As can be seen from the photographs, the final effect is extremely satisfactory. A very important aspect of the design is the almost complete absence of specials. With the exception of the wrought-iron gasoliers, standard equipment has been used throughout—a classic example of what can be done when architect and lighting engineer collaborate from the very beginning of a scheme.

The University Team consisted of Dr James Bell and Mr Donald Buttress, who gave architectural and lighting advice; the Buildings Officer, Mr Jack Butterworth; Mr Fred Garside, the Assistant Buildings Officer; and the Electrical Engineer, Mr Norman Wilkins, to all of whom we are grateful for help in writing and illustrating this article.

electronic dimming systems

by B Massey and I J Bramson MISTC

With the general introduction of electric lighting at the end of the nineteenth century, many minds applied themselves to the problem of finding an electrical equivalent to the one advantage which gas lighting had to offer, namely, continuously variable control of brightness. The advantage was particularly evident in the theatre where the use of gas lighting, although presenting something of a fire hazard, had permitted considerable flexibility. To be acceptable to the lighting men of those days, electricity needed to offer a comparable facility.

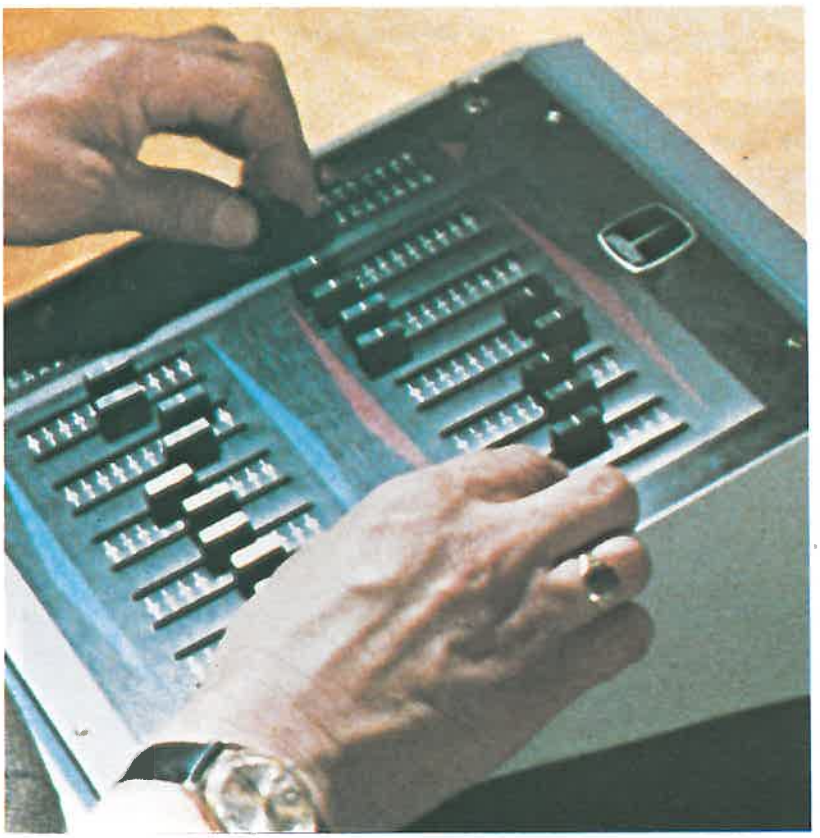
Early attempts to control the d.c. installations ranged from arrangements in which copper rods were immersed for a greater or lesser part of their length in conductive chemical solutions, to large wire-wound rheostats commonly controlled by means of hand wheels. In both cases much waste heat was generated and in the former arrangement the inconvenience was aggravated by corrosion and a tendency to generate noxious gases.

With the introduction of a.c. supplies in the early 1930s improved control became possible by two methods, the variable transformer and the saturable reactor. Both of these offered a reduction in wasted power, and saturable reactors were amenable to remote electrical control. However, both types were expensive and, because of their iron-cored inductors, were heavy and bulky.

It was not until the late 1930s that the advent of the gas-filled thermionic triode known as the 'thyratron', introduced an era in which electronic control techniques have resulted in dimmers which are now compact, efficient, inexpensive and controllable by means of a convenient low power d.c. signal.

The thyratron was the forerunner of the solid state device, now known as the thyristor, itself a precursor of the triac. Both devices are in current use as very high speed electronic switches controlling the energy

B Massey and I J Bramson are members of the Theatre Lighting Division of Thorn Lighting.



Constantly changing lights make a swinging scene. The Club 10 control unit can be seen in the background.

Control panel for Thorn Club 10.

supplied to the lamps but without themselves dissipating any appreciable amount of power. Dimmers employing this device are controlled by a low voltage d.c. signal—typically 10V at 1–2mA. This approach has resulted in dimmers which are very compact and have negligible power losses.

The theatre, then, was the first user of electronic dimming systems and, with television studios, remains the prime market for large installations. However, dimming methods are now finding application wherever artificial lighting is used and are equally applicable to both tungsten filament and fluorescent light sources.

Purpose-built equipment is now commercially available for installations ranging from a single lighting circuit to the most ambitious opera house application. The theatre-related establishments, discotheques, etc, are well catered for, as are bars, schools and restaurants. Economical, small and highly portable versions of the modern theatre lighting control system are currently available for any establishment making use of a small stage. In restaurants and pubs these systems may be employed to provide 'mood' lighting, using shape and colour to the maximum advantage. If a cabaret or other show is to be staged in the evening, a simple readjustment of the controls provides professional style stage lighting.

A good example of this type of control system is the Thorn Club 10 in which a lighting cue or state can be set up while the previous one is still in use. The equipment illustrated in Figure 1 employs a compact assembly of ten electronic dimmers and any combination of lanterns up to the maximum rating of the dimmer (2.5 kW) can be connected to each one of the ten circuit outlets. The control unit shown in the lower illustration is remote from the dimmers and is usually positioned at that point off stage which affords the best view for the operator. This unit operates at low voltage and is fitted with two rows of faders or control levers, each row being provided with a master fader. The latter allows control to be transferred at any chosen rate from one row or 'preset' of faders to the other, thus changing the lighting to the next required state.

The Club 10 is also the nucleus of a self-contained kit which includes all the lanterns, cables, filters, etc. required to build a basic stage-lighting installation. This package, called the Clubmaster, allows professionals or amateurs alike to achieve good results on a do-it-yourself basis. It can be expanded if necessary to suit a larger production.

Used with a similar dimmer pack, the Thorn Club Disco typifies a range of special purpose control units. These not only allow manual control of the light level of several different circuits from a single multi-control panel but can also allow some circuits automatically to pulse or fade from colour to colour according to the pitch, loudness and rhythm of a signal from a sound source. At the same time other circuits cross-fade continuously from one to another at predetermined speeds. This type of apparatus is useful in ballrooms and in restaurants with dance floors, since the same controls which provide these spectacular effects can, at the touch of a switch, give lighting conditions to produce a more restful atmosphere.

For more complex installations, sophisticated manual control systems are available. In the Thorn Series PM control board illustrated in Figure 2, the circuits, although individually controlled, can also be grouped to common master faders by the insertion of miniature contact-pins in a matrix of sockets. This renders the system more flexible and suitable for use with fast moving variety shows or complex dramas.

Larger theatres and TV studios use control systems with computer-type ferrite core stores which provide both circuit selection and circuit intensity memories. The Thorn Q-File and Q-Master equipments, typical of the ferrite memory systems, have been supplied to many theatres and TV studios throughout the world. These allow a

Figure 1

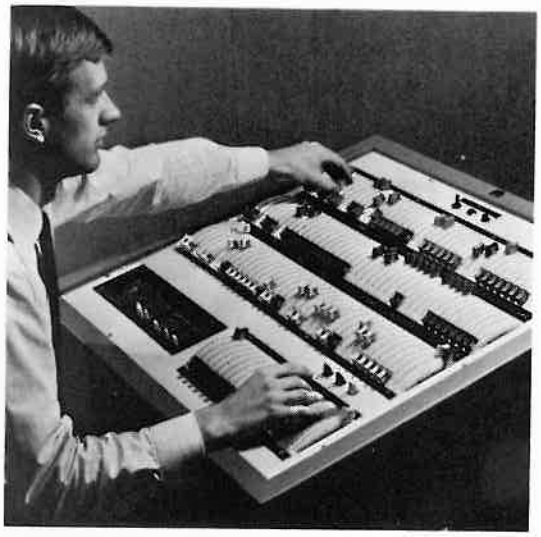


Figure 2

complete lighting state to be recorded at any time in one of up to 200 electronic memories. At the touch of a button any of these states can be recovered instantaneously or faded in to replace or supplement an existing lighting arrangement as quickly or slowly as required. Aurama, the Thorn control system for Son et Lumière, employs an electronic memory system and utilises a signal pulse from the unused track of the sound tape to change the floodlighting of buildings to synchronise with the narration and sound effects.

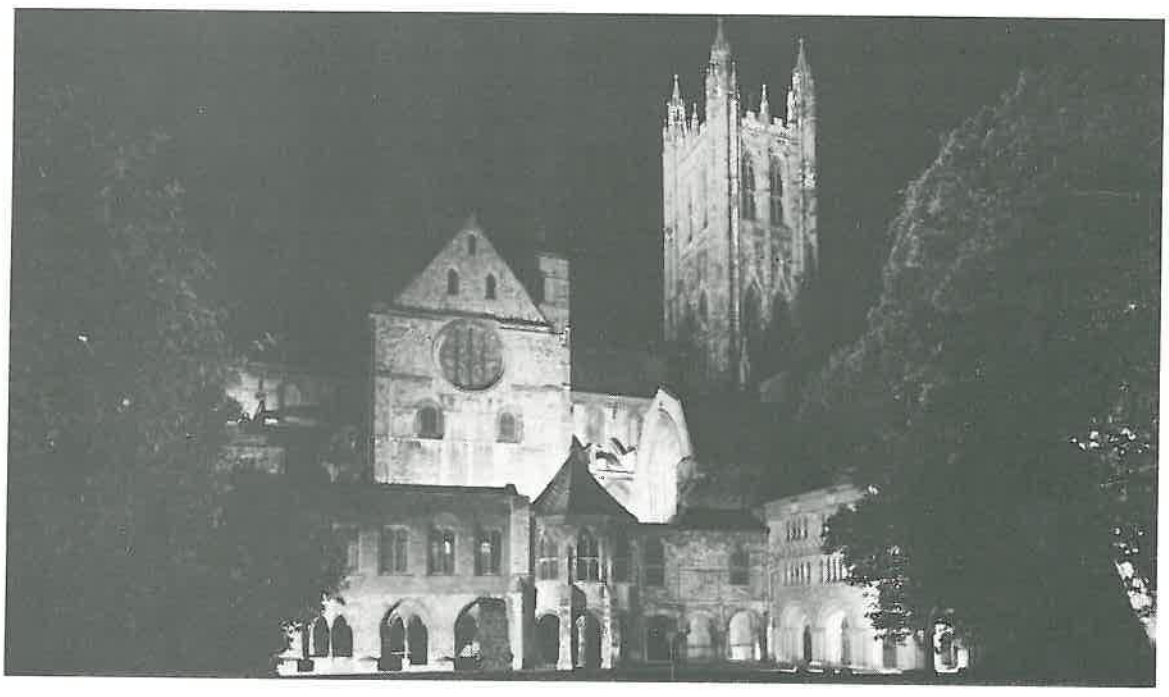
Lighting controlled by means of electronic dimming can be used on art displays, fountains, waxworks, etc, to produce a suitable atmosphere or to tell a story. Such systems are often controlled by a photo-electric cell arrangement which is activated when a visitor passes through the beam, or they may be mechanically or manually controlled.

Theatres, cinemas, lecture halls or conference suites using any form of slide or film projection require controllable auditorium lighting and dimmers having simple remote controls are available for this and similar applications. These remote controls take the form of a rotary knob or set of pushbuttons which respectively allow manual adjustment of brightness, or initiate automatic changes at a pre-determined rate between off and full light or some intermediate level. Units of this type are available to control either tungsten (including tungsten-halogen) or fluorescent lighting and the Thorn Series H range is a good example.

A combination of the last-described units and the photo-electric arrangements described earlier can be used in many interesting ways. For example, the lighting at the mouths of road tunnels can be automatically adjusted according to the daylight level and hence allow a less abrupt and safer transition between natural and artificial illumination. Shops, offices, factories and art galleries can have controls which maintain a set level as the daylight changes. Plants and animals can have their environments controlled in a manner which favours their optimum growth and development.

Other applications of controlled lighting are manifold. For example, hospital operating theatres can benefit by having the right amount of light of the right colour in the right place; and mental hospitals can use control of illumination level and colour to achieve a therapeutic effect.

Son et Lumierè at Canterbury Cathedral



some recent installations

A Cofferlight ceiling provides glare-free illumination in an architect's office.

Right: Atlas Halide floodlights light a trotting track near Cannock, Staffs.

Above: Day and night views of outdoor lighting at Bass Charrington, Runcorn.

Right: The ceiling of the smaller concert hall at Stockholm lit by Atlas Sunfloods.

some recent installations

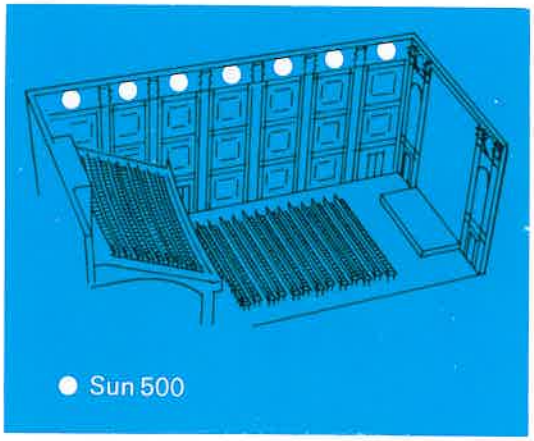
Technical notes

Cofferlight ceiling

The architectural firm of Peter M. Caller and Associates has chosen a Thorn Cofferlight ceiling for the new drawing office in Newcastle upon Tyne. The offices are housed in a Georgian building in which ceiling heights are limited and the elegant Cofferlight permits a high level of illumination without glare.

A factor which influenced the choice of Cofferlight was that it is based on the 5ft 65W fluorescent lamp which has a higher lumen output than the 4ft 40W lamps around which similar systems are designed.

Twin Atlantic 4 fittings are used without diffusers in the 300mm deep, 600mm x 1800mm coffers which are supported by a single channel system. Designed illumination at the drawing board is 2000 lux.

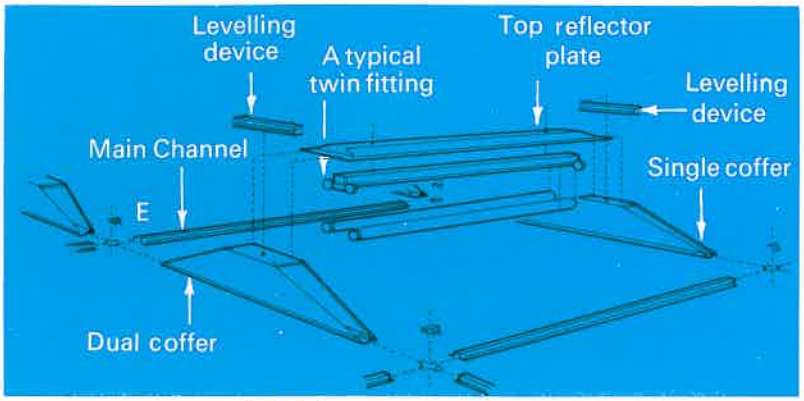


Trotting track

The only purpose designed trotting track in England is at the Chasewater Raceway near Cannock in Staffordshire. To allow evening meetings throughout the year a permanent floodlighting installation consisting of 128 Atlas Halide HAS 1500 tungsten-halogen floodlights is installed. The floodlights are mounted on 8m Abacus tubular steel columns which can be hinged down at the base by means of a hydraulically operated counter-weight system for lamp maintenance.

The floodlights are mounted in pairs except for the eight poles immediately in front of the grandstand where there they are arranged in sets of three.

The designed horizontal and vertical illuminances on the main circuit are 150 lux and 200 lux respectively. In the grandstand area the values are 200 and 300 lux.



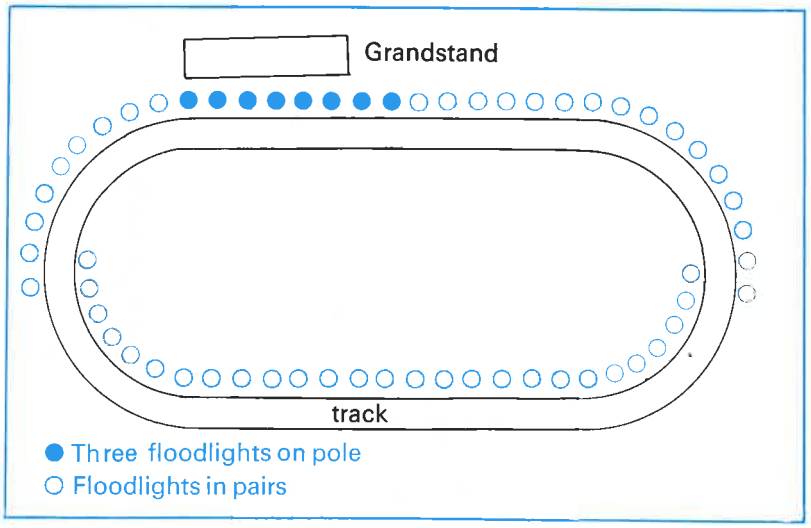
Exploded view of Cofferlight

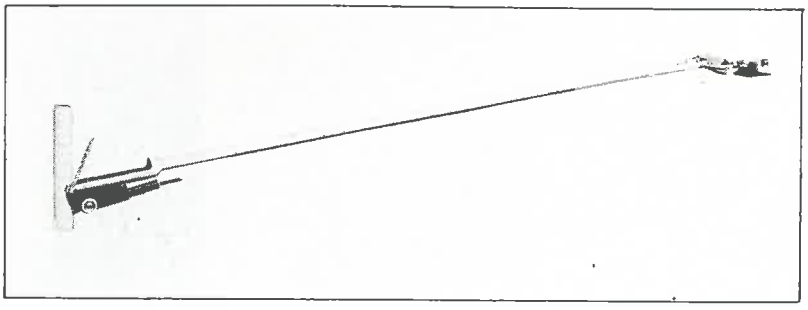
Stockholm concert hall

Stockholm's concert hall is one of the most elegant buildings in the city and is the scene of the annual distribution of Nobel prizes.

The smaller hall, used for chamber concerts, was originally lit by decorative pendants which, though elegant, failed to illuminate the painted ceiling adequately. To overcome this, extra lighting has now been provided from 14 500W tungsten-halogen lamps in Atlas Sunfloods mounted in the shallow cornices below the ceiling in each bay. The extra light cast on the paintings has brought out details hitherto unperceived, and the fittings are mounted far enough from the ceiling for there to be no heating problems.

Sunfloods have also been used for emergency lighting and to supplement the lighting of foyers and cloakrooms.





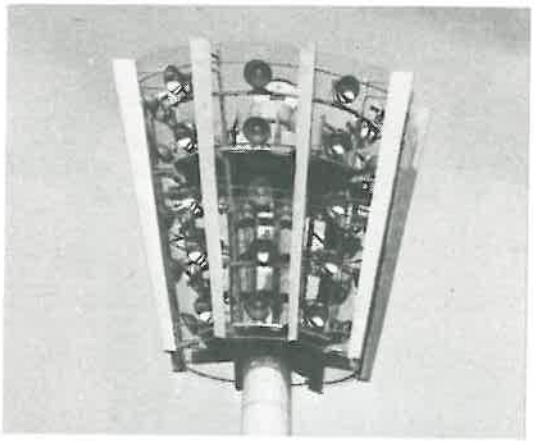
Bass Charrington

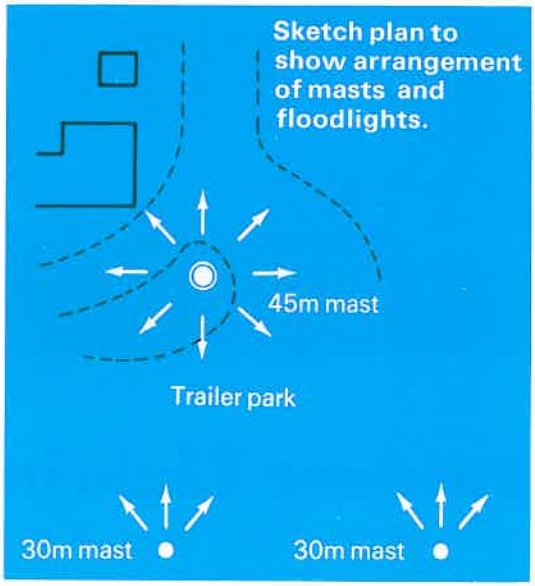
The floodlighting of a building site is by no means uncommon : what is less usual is an installation designed to be used both during construction and after the building is completed.

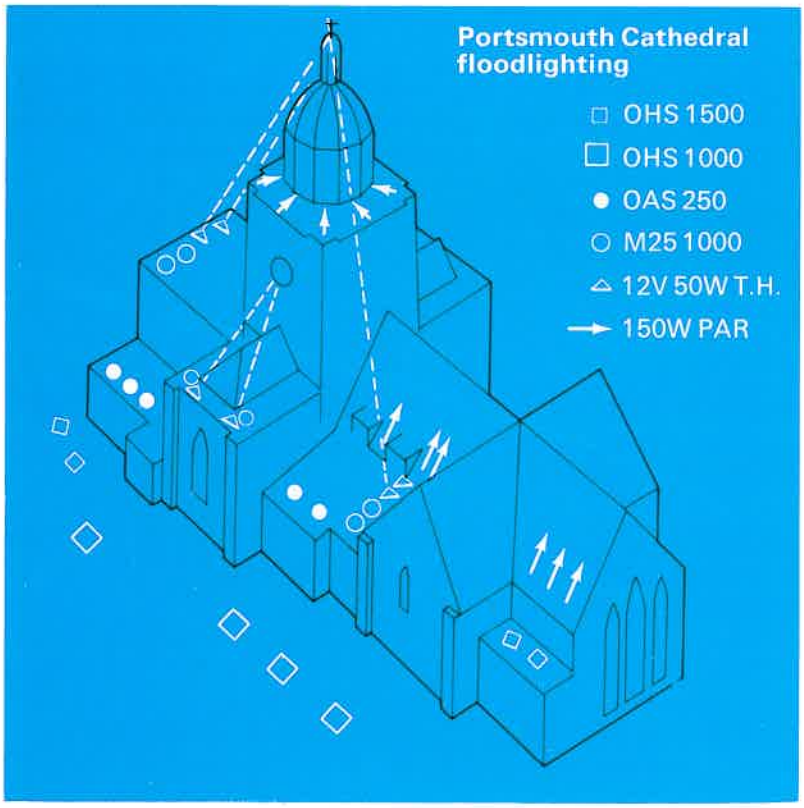
The system at Bass Charringtons' new bottling plant at Runcorn is based on three Petitjean masts, each carrying a 'corona' of floodlamps ; access is by a ladder within the hollow steel mast.

The 45m main mast, lighting the entrance area, supports 40 M25 floodlights each housing a 400W KolorSON lamp mounted at an angle in the crown-shaped frame to give an illumination of 20 lux at ground level. Control gear is housed within the mast.

Supplementary lighting for the trailer park is by two 30m high masts each carrying 24 floodlights ; these light areas which would otherwise be in shadow cast by the lighting equipment on the main tower. A general street lighting installation is provided in other parts of the site.







Portsmouth Cathedral (Page 22)

The central tower of Portsmouth Cathedral, completed in 1691, replaced the western tower of the original thirteenth-century cruciform parish church which now forms the choir of the cathedral. It has an octagonal bell-chamber supporting a lead cupola, terminating in a lantern and weathercock.

The flat roof of the modern nave and western transepts accommodate six M25 floodlights, each housing a 1000W lamp, to floodlight three walls of the tower ; with six specially designed low voltage spotlights, housing 12V 50W tungsten-halogen lamps, to pick out the clock on the south face of the tower and the weathercock.

The octagon and choir roofs are lit by 150W PAR lamps mounted on the flat roof of the tower and above the eves of the pitched roof of the choir and the lower walls of nave and choir by tungsten-halogen lamps in OHS/500 reflectors mounted at ground level. The upper walls are picked out by 250W KolorSON lamps in area floods mounted on the flat aisle roofs.

The scheme was designed by Portsmouth City Architects' Department in close liaison with Thorn Lighting engineers and was installed by the Southern Electricity Board.

Outdoor Lighting Awards 1975

Although there are two years yet to go, considerable interest is already being shown in the Outdoor Lighting Awards timed to coincide with the London meeting of the CIE in the autumn of 1975. The sponsoring bodies are the Civic Trust, the Electricity Council (which will administer the scheme), the Lighting Industry Federation, the Local Authority Association of Great Britain and the Tourist Boards of England, Scotland, Wales and Northern Ireland (but *not,* as reported in the last issue of *Lighting Journal,* the IES). It is felt that the following details will prove useful to those contemplating entry.

Any body or corporation responsible for a suitable building or area is eligible to enter for the competition. Awards will be made for outstanding examples of the exterior lighting of buildings and open areas intended for the enjoyment of the public and the Sponsoring Committee offers to put would-be candidates in touch with lighting specialists where necessary.

Awards will be made in three classes :

(a) Individual buildings, structures and their surroundings ;

(b) Urban areas ;

(c) Areas of natural landscape.

All installations must have been first switched on not earlier than 1 July 1972 or later than 31 December 1974, must be in use at all appropriate periods during 1975, be within the United Kingdom and be visible to the public without charge.

Entrants will be asked to submit photographs of their entries but the actual judging will be on site. There is no entrance fee.

Full details of the scheme may be obtained from the Secretary of the Sponsoring Committee, 1975 Outdoor Lighting Awards, Trafalgar Buildings, 1 Charing Cross, London SW1A 2DS.

Picture shows Portsmouth Cathedral floodlighting described on the previous page.

lighting a London underpass

London's newest underpass, recently completed by the Greater London Council, carries the south-bound carriageway of the A11 under Wick Road, Hackney. It consists of a 152m (500ft) long curved tunnel with three lanes of traffic.

The basic lighting is provided by two continuous cornices consisting of twin-lamp 5ft 65W fluorescent luminaires mounted end to end and producing an average illuminance of 250 lux by day and 80 lux at night when half of them are switched out. On a bright day the illumination at the entrance is raised to 3 000 lux and reduced by two stages of 2 000 lux and 1 100 lux to the basic level by means of Thorn KolorSON (SON/T) lamps in specially designed reflectors. On dull days, when the illumination outside falls to less than 20 000 lux, half the lamps in the initial stage are switched out by means of a photocell located near the entrance. This reduces the illuminance to the same level as that in the second stage.

By this means, drivers' eyes gradually become accustomed to the lower illumination in the tunnel and the effect of being suddenly plunged into darkness is avoided.

In the first 50m long section of the tunnel, transverse troughs about 600mm wide have been formed in the concrete on 1.5m centres. In each of them are two specular reflectors each housing a 400W clear-glass high-pressure sodium lamp (SON/T). These reflectors are tilted towards the entrance of the tunnel and, with the fluorescent cornices, produce an illuminance of 3 000 lux at road level. Tilting the

Vehicles enter a brightly lighted area. Further on the illumination is scaled down.

Start of the second section showing how the spacing of the lamps is doubled.

reflectors increases the apparent brightness of the walls and roof of the tunnel and also reduces the brightness of the unavoidable reflections of the lamps which appear to chase each other down the rear window and polished surfaces of the car in front.

On a dull day, when the external illuminance is less than 20 000 lux, alternate pairs of these fittings are switched out in the first section of the tunnel, thus increasing their effective spacing to 3m and reducing the illumination to 2 000 lux, the same as that of the second section, in which the spacing of the troughs has been increased to 3m.

In the third 50m section the troughs are still spaced at 3m, but the power of the SON/T lamps is reduced to 250W, bringing the total illuminance in that section down to 1 100 lux. The remaining part of the tunnel is lit to 250 lux by the fluorescent cornices only. Table A shows the relationship between external illuminances and the tunnel lighting.

The fittings housing the KolorSON lamps were made by Thorn Lighting to the design of engineers of the Electrical Services Division of the Department of Architecture and Civic Design of the GLC. They are totally enclosed, with a clear glass gasketted visor and polished anodised aluminium reflector of parabolic cross-section. The electrical and installation work was carried out by Green and Silleyweir, working under the main contractors.

The warm light of the KolorSON lamps contrasts with the cool colour of the fluorescents so that the impression given by the latter is that of a long line of clerestory windows admitting natural daylight. This very much lightens the appearance of the structure and eliminates the claustrophobic effect often felt in tunnels and underpasses.

External conditions in approach road	Zone I 50m	Zone II 50m	Zone III 50m	Basic 152m
Day (above 20 000 lux)	58 400W SON/T Soffit fittings 50 2 x 5ft 65W cornice fittings Average lux on road **3 000**	32 400W SON/T Soffit fittings 56 2 x 5ft 65W cornice fittings Average lux on road **2 000**	32 250W SON/T Soffit fittings 56 2 x 5ft 65W cornice fittings Average lux on road **1 100**	148 2 x 5ft 65W cornice fittings Average lux on road **250**
Day (less than 20 000 lux)	30 400W SON/T Soffit fittings 50 2 x 5ft 65W cornice fittings Average lux on road **2 000**	32 400W SON/T Soffit fittings 56 2 x 5ft 65W cornice fittings Average lux on road **2 000**	32 250W SON/T Soffit fittings 56 2 x 5ft 65W cornice fittings Average lux on road **1 100**	148 2 x 5ft 65W cornice fittings Average lux on road **250**
Night	18 2 x 5ft 65W cornice fittings Average lux on road **80**	20 2 x 5ft 65W cornice fittings Average lux on road **80**	20 2 x 5ft 65W cornice fittings Average lux on road **80**	74 2 x 5ft 65W cornice fittings Average lux on road **80**

Table A

decorative incandescent lamps

by G E Coxon BSc PhD

Historical background

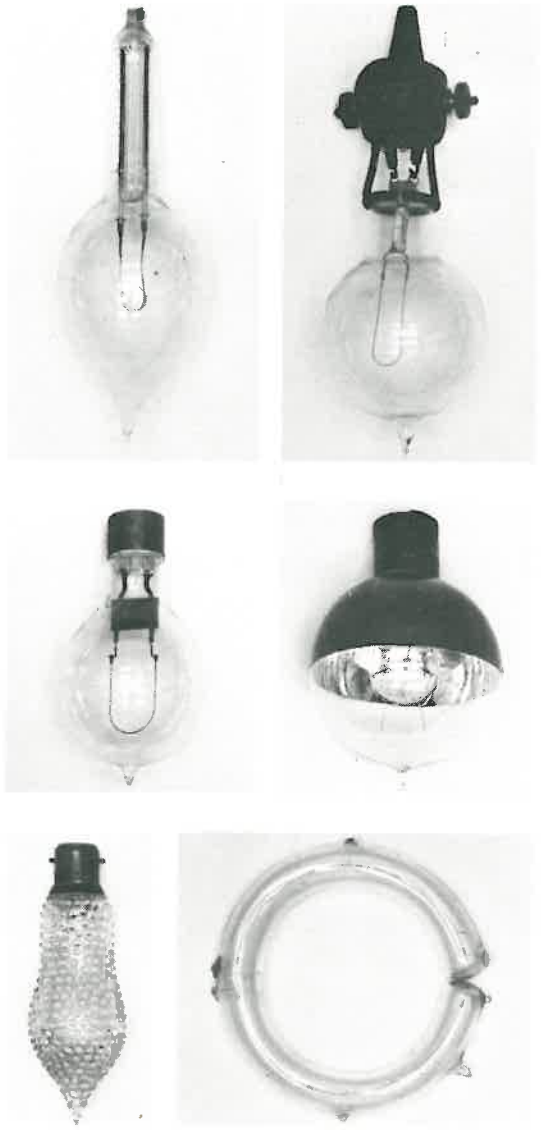
An examination of the catalogue of lamps and prices of the Edison and Swan United Electric Company of 1892 shows an astonishing range of carbon filament lamps which are highly decorative and serve particular purposes. This is all the more remarkable when it is remembered that the carbon filament lamp became a commercial possibility only in 1878 after Edison and Swan had turned their attention to this material.

Among the decorative or 'Fancy Lamps' as they are called which take the eye are lamps with hand-cut glass bulbs at 8s. each whose intricacy would infer that after filament failure the bulbs could be re-used. Candle lamps with conical crinkled and spiral form bulbs are described. Coloured lamps were sold with a wide range of natural coloured glass bulbs at extra cost (4s. clear, 6s. coloured).

Many of the bulbs described are approximately spherical in shape. Undoubtedly this is the most convenient shape to blow by hand but it is also the strongest shape from the practical point of view when one remembers that these lamps enclose a high vacuum. Many of the decorative lamp bulbs of this period were designed to replace existing light sources such as rush lights, wax candles, oil lamps or gas mantles. One manufacturer of this period sold tubular, conical-ended lamps incorporating a carbon filament to replace candles (cost 5s. each). The company promised to pay the sum of 1s. 3d. for failed lamps, the object being to recover platinum from the lead-in wires.

Various materials, including tantulum, were tried as alternatives to carbon filament and between the two World Wars metal filament lamps using tungsten almost completely replaced carbon filament incandescent lamps; but recently the latter have reappeared in Europe as decorative lamps.

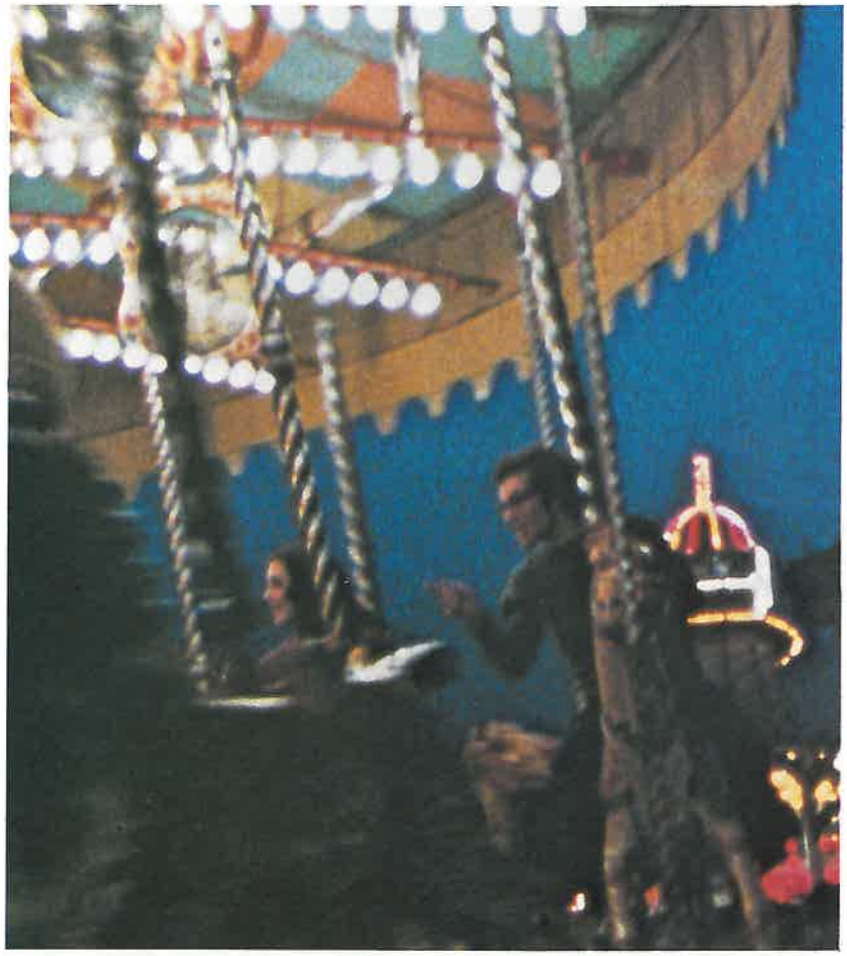
Linear incandescent source lamps also first appeared during this period and were used for architectural and display purposes. The linear tungsten coiled filament is suspended from a glass tube by metal supports running the length of the lamp. Electrical connection is made at either end or, in many cases, at a point at the side of the tube near to each end. Contact was originally made with the lampholders in this type by using a peg terminal on the lamp and a clip and locking device as holder which often gave trouble. The advantage of the side peg contacts is that a continuous strip of light can be produced, lamps being butted together. Curved lamps were also produced. The clear, linear 'Striplight' is often used today in showcases containing jewellery to provide the extra glitter lacking when a more diffuse source is used.



Some of the earliest carbon filament lamps from the Thorn collection.

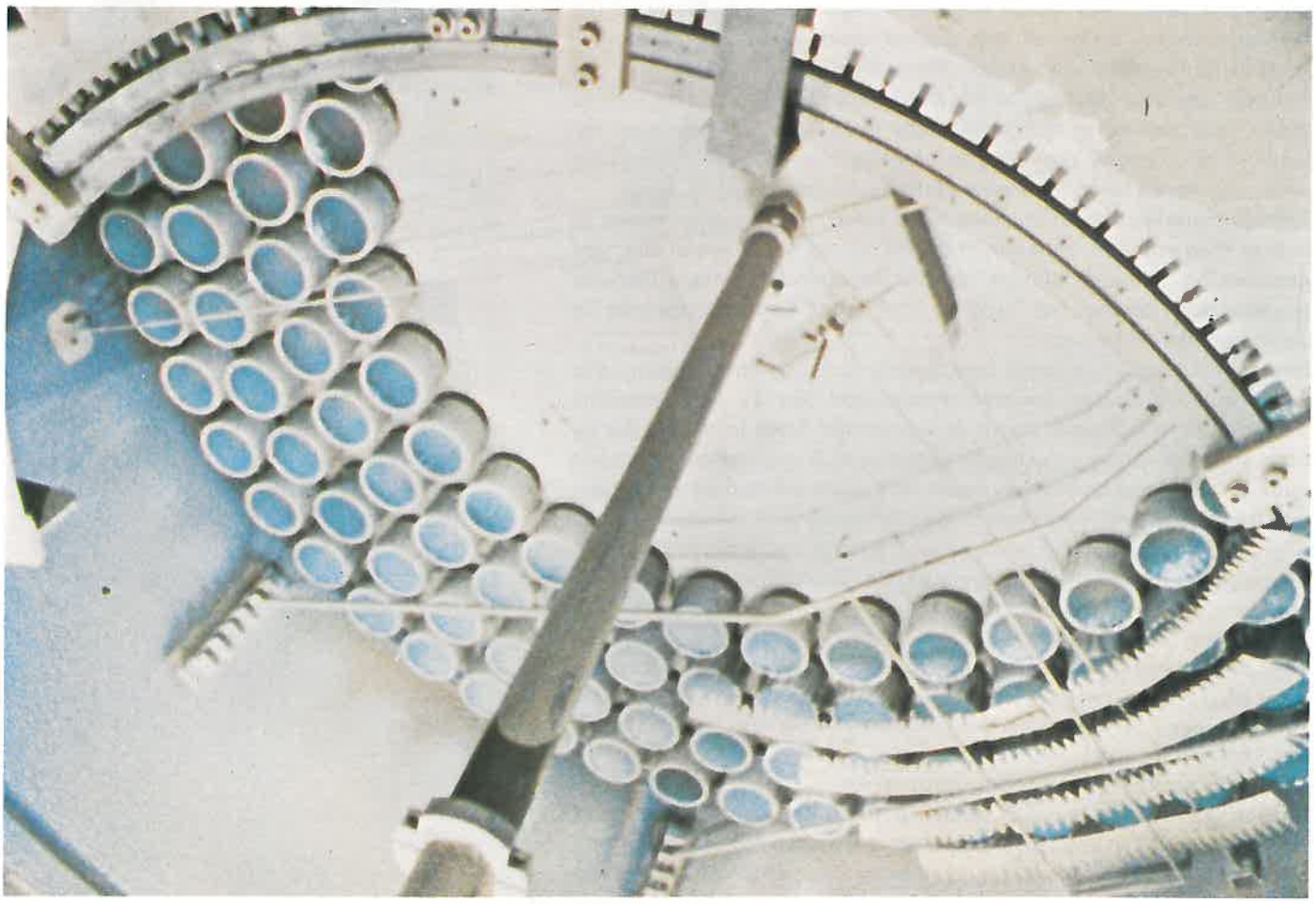
Modern decorative lamp developments

A resurgence of interest has arisen in the aesthetic appearance of lamps as well as in the quality and beam characteristics of the light produced. In some cases lamps have been designed with a coloured



Coloured lights are part of the fun of the fair.

Below: Material for coloured dichroic filters is deposited on the rotating front glasses of the lamps in this impressive machine.



finish which reduces the intensity of light. Lamps have been designed purely for their appearance and become an integral part of the design of the luminaire. These lamps are usually larger and more expensive but have a longer life than a standard lamp.

Bulb design

The renewed interest in these types has resulted in a fresh design approach with modern techniques of mass production in mind. For example, high-speed lamp manufacture requires that glass bulbs be positively located in sealing-in cradles so that the relationship between the bulb and the inner filament mount construction is fixed. This problem demands that the shape of the bulb, particularly the neck area, must allow positive location or special sealing-in cradles must be produced.

Two further points must be noted when a design is specified. The waste glass, or cullet, which falls away from the lamp after sealing-in, must do so under its own weight in high-speed production. A sufficient weight of waste glass must be left for this to occur. A further point is the necessity for accurate repetition of wall thickness on different bulbs travelling through a constant set of fires.

Mazda Decor round and Purlux lamps.

Decorative finishes

Modern techniques of high-speed production of glass bulbs for decorative purposes also place restrictions on the type of bulbs available. It is inconceivable that the economic production of natural coloured and textured glass bulbs can take place using these methods. Colours and textures must be applied to bulbs or finished lamps as an extra operation. A number of methods and materials have been developed which are employed in the modern production of decorative lamp types.

Coloured lamps are produced either by internal or external coating of the surface of the bulb with pigments. When the lamp is in use it is necessary to ensure that the heating effect of the colour coatings neither raises the bulb wall to temperatures which release impurities nor the cap region to unacceptable limits.

The methods of colour application available to the lamp designer can best be described by using particular examples of decorative lamps from the Mazda range.

Decor lamps

The Decor range consists of a number of large decorative lamps designed for an aesthetic as well as a functional purpose with an increased service life. The bulb shapes range from the angular doorknob shape through the slender cone bulb to the large round lamp.

All of these bulbs can be supplied with the Silverlight coating, giving an even white diffuse light, more efficient as a light producing unit than a combination of lamp and separate diffuser. This coating is applied as an aqueous suspension of freshly precipitated silica to the inside of the clear bulb. The coating is baked to remove the special binders and the bulb immediately transferred to a lamp-making unit. This type of suspension with the addition of a coloured pigment is used in the internal coating of low wattage lamps using standard pear-shaped bulbs and also in a wide range of small GLS lamps used in illuminated signs and as pilot lamps.

The Decor round lamp is also supplied in clear, red, green, purple and amber externally lacquered forms. The lacquers are special organic thermosetting paints which contain expensive pigments and resins which will withstand high temperatures in use (high temperature capability) but even so the rating is restricted to 40W for this large bulb. Automated spraying equipment with high temperature stoving facilities has been developed to produce these coatings on lamps of all shapes and sizes at high speed.

These lacquers must not only have high temperature stability through life but also have a sufficiently moderate curing temperature that does not affect lamp quality during processing, that is, the temperature in the oven must not exceed the normal running temperature of the lamp.

Coloured display lamps

The 75W and 40W coloured display lamps provide coloured light in a directional beam produced by placing the filament at the focal point of a paraboloid which is an integral part of the blown glass bulb. The interior is coated with a highly reflective material, usually vacuum-deposited aluminium, and since the atmosphere within the bulb is inert the condition of this coating is maintained throughout the life of the lamp. The colour is provided by a coating of slightly translucent coloured lacquer, of extremely high temperature capability, over the front of the lamp. Colours provided are red, green, blue and yellow.

Dichroic coatings

The problem of ultimate fading and peeling of organic coloured lacquers when applied to lamps which run unusually hot restricts their use to particular wattage ratings and bulb size combinations. Although organic lacquers can be safely used for the 100 watt lamp the 150 watt version is too hot for this technique to be employed.

One heat-resistant colouring process makes use of the selective optical properties of so-called dichroic coatings. This process has been applied to production of colour in the hard glass, long-life sealed beam display lamps, e.g. the 150 watt Color-ray PAR 38 lamps. The dichroic effect relies upon the interference produced by coating the internal surface of the lens with a series of alternate layers of two different transparent inorganic materials. Red, yellow, green and blue coloured display beams are produced. Multi-layer coatings can be laid down to transmit only the long wavelength (infra-red) radiation to reflect the wavelengths in the visible spectrum. Reflector coatings of this type are present in the Cool-ray 150W lamp. This technique is described more fully in *Lighting Journal* no. 8.

Crown silvered lamps

The modern trend of using incandescent lamps as an integral visual part of the lamp/fitting combination is well shown in the use of crown silvered lamps. Crown silvering is the vacuum coating of the interior crown of the bulb with a reflective layer of aluminium to a point on the bulb which just obscures the filament position. Light from the filament is reflected back through it from the inside crown and emerges through the lower half of the lamp. Such lamps are used in the silvered spotlight extensively employed for shop window illumination, the use of the half-silvered bulb with parabolic reflectors eliminating spill light in the beam. Another use is as part of large fittings providing frontal illumination from these lamps where the filament is obscured from view. In the former case colour can be produced by use of a coloured spun anodised aluminium reflector.

Conclusion

In conclusion, it can be said that this new trend of emphasising the design of decorative GLS incandescent lamps is to some extent reminiscent of similar usage in the early days of electric lamps. Illustrations showed that lamps were developed in the past as direct substitutes for existing primitive light sources and were meant to be used as decorations in their own right.

The use of modern designs, materials and techniques by lamp engineers has enabled new incandescent lamp types to be developed and to show that this basic method of lighting, now almost in its second century, has still something to offer in the face of the more efficient and sophisticated discharge sources in the field of decorative interior lighting.

Decor spot lamps

kite-marks and approval marks

by R C Kember, C Eng BSc Eng (Hons) MIEE MIllum ES, L H Da Volls and J E Greenhill C Eng MIEE MIllum ES

Most people are aware that official approval marks are widely employed on the continent and that in several countries the sale of electrical equipment without such a mark is forbidden. The use of such marks has obvious advantages since they signify that the goods conform with tests made at an independent testing station and that the standard is maintained by the manufacturer. They protect the consumer against unsatisfactory or unsafe products and the vendor from being held responsible for any harm resulting from their use. They also act as a trade barrier against unsatisfactory goods. With certain exceptions, the testing and marking of electrical goods in this country has been carried out on a voluntary basis, such organisations as the British Standards Institution having been set up jointly by Government, manufacturers and consumers to define standards and to regulate test procedures. There are, in fact, at least ten different approval marks currently in use in the United Kingdom, not only concerning electrical goods but such commodities as oil heaters and woollen goods. Three of the best known in the electrical field are the BSI Kite-mark, the BEAB mark used on consumer durables and the certificate of the British Approval Service for Electrical Equipment in Flammable Atmospheres (BASEEFA) which certifies compliance with the relevant British Standard and is mandatory in certain situations.

The low voltage directive

In February this year an important document entitled *The directive on the harmonization of the laws of Member States relating to electrical equipment designed for use within certain limits* was issued by the Council of the European Communities at Brussels. Usually referred to as the Low Voltage Directive, it is designed to facilitate trade between member countries by harmonizing their safety regulations for electrical goods, since these differ considerably at present both in technical content and in the amount of freedom they allow for up-dating. As a first step to the removal of the barriers to trade caused by such differences it is proposed that member countries should recognise each other's marks or certificates of safety and that these should be published in the Official Journal of the European Community. The members should also harmonize their standards so that they should be recognised throughout the community. The

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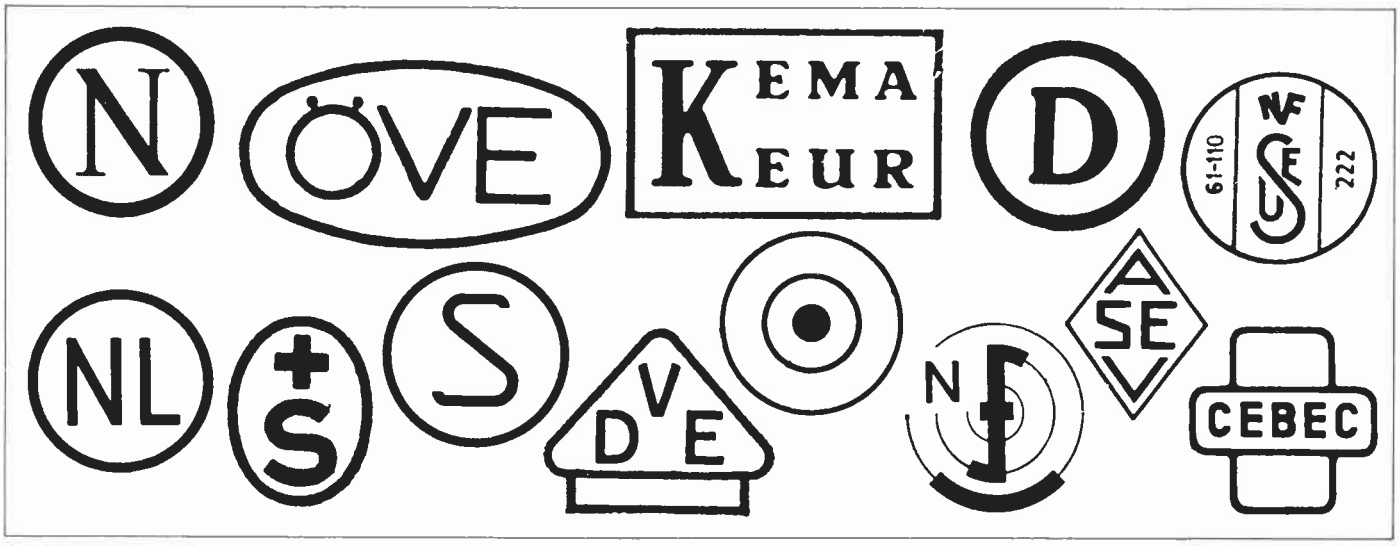

directive consists of a preamble and 14 articles. The first of these limits the scope to 50 – 1 000V a.c. or 75 – 1 500V d.c. The next three articles require governments to legislate so that only safe goods may be placed on the market, that free movement of such goods is ensured, and that stricter requirements may not be imposed by electric supply authorities. Articles 5, 6 and 7 deal with harmonisation of standards and indicate preference for IEC or CEE published recommendations. Articles 8 and 9 cover problems associated with safe equipment, which does not fit the harmonised specifications, while articles 10 and 11 require mutual recognition of safety marks and certificates of safety. The remaining articles deal with administrative matters. Article 13, perhaps the most important, demands that member states "shall put in force the laws, regulations and administrative provisions necessary to comply with the requirements of the directive within eighteen months of its notification and shall forthwith inform the Commission thereof". There are two appendices, one listing the safety objectives for equipment, and the other exemptions from the directive.

Legislation is being prepared by the Government, the result of which will be that all goods sold will have to comply with these requirements. Since British Standards on lighting equipment are in general harmonised with international specifications this means that the Kite-mark will rank among these, guaranteeing appropriate safety standards.

The BSI Kite-mark

The BSI has long led the world in setting safety and quality standards and its requirements are accepted by all reputable manufacturers. A new British Standard for Luminaires, BS 4533, has recently been issued and only luminaires that conform with it will be demanded by enlightened consumers in this country. This new standard, entitled *Specification for Electric Luminaires* (*Lighting Fittings*), consists of a number of separate parts or books and uses other BS specifications as references for screw threads, lamps, ballasts, lampholders, etc. Conformity with this specification is the basis of the kite-mark system for luminaires and was promoted jointly by the Lighting Industries Federation and the BSI. The Kite-mark already has a very real significance to the professional user and to most manufacturers, and its value is beginning to be realised by the ordinary shopper. It is an independent assurance that the product on which it appears meets the requirements of the British Standard that defines its essential qualities. A manufacturer must be licensed by the BSI before the Kite-mark can be used and such licensing includes the assurance that adequate test facilities, up to the requirements of the BSI, are available to the manufacturer. A luminaire or other piece of equipment may be kite-marked only after it has passed rigorous testing in the BSI laboratories and after the laboratories have assured themselves that the manufacturer has the ability to produce a consistently acceptable product. The initial guarantee of safety and quality is maintained by sustained inspection of the factory by the BSI to check the manufacturer's quality control, to examine his records and to select random samples for full testing. A great deal of work must be done by designers, laboratory and factory staff to ensure that products conform. All this costs money – perhaps 1% of the product value—but it is worthwhile because of the confidence engendered in customers in products bearing this mark.

The increasing demand for luminaires bearing these approval marks and the consequent desire of leading manufacturers to conform has put a very heavy load on the BSI. It was decided by the LIF and the BSI that the first priority was domestic luminaires as these are often installed by non-professional people, thereby increasing the possible hazards. Thorn's first submission therefore included table and floor standards, wall-mounted luminaires and mirror lights, all of which

BSI Kite-mark

BASEEFA mark

BEAB mark

passed the appropriate tests. The examination of the complete range of commercial and industrial fluorescent, incandescent and discharge lamp luminaires by the BSI is now in progress.

Classification of mounting surfaces

The necessity to classify mounting surfaces has been recognised internationally and these are now likely to be divided into three groups: non-combustible, such as concrete or brick; normally flammable, such as wood planks or ceiling-board on wooden joists which have an ignition temperature of at least 200°C and will not deform or weaken at this temperature; and materials outside this range which are readily flammable and on which no luminaire should be directly mounted. New regulations are coming into force for the second category and it is likely that only in the case of ceilings made of non-combustible materials will close contact with the ballast be allowed. An interesting development which is being studied for international acceptance is the German "F" mark, designed to guard against the danger of the breakdown of a ballast at the end of life constituting a fire hazard. It is well known that towards the end of its life the insulation of a choke's windings may break down, resulting in a partial internal short circuit with consequent serious over-heating. All reputable manufacturers who conform with the British Standards ensure that the normal temperature of the parts of a luminaire which are in contact with the ceiling are well within the safety limits, but until recently the danger of fire due to the end-of-life conditions in ballasts had not been covered apart from the use of thermal cut-outs in some installations.

German 'F' mark

The German solution is so to design the luminaire that the surface on which it is mounted will not reach a dangerous temperature even when there are faulty components. This can be achieved by spacing the ballast away from the luminaire and the luminaire itself away from the ceiling or mounting surface.

In America a totally different approach is used so that thermal cut-outs come into operation when the temperature of the ballast rises above its normal level long enough to be dangerous.

The design of Thorn Lighting luminaires will progressively take these factors into account, so that mounting surfaces cannot reach a dangerous temperature even under faulty conditions. In the interim, a cut-out device has been developed so that even luminaires which do not fully comply with these requirements can be protected, as for example those which have been installed for a number of years. Bearing in mind that the normal rated life of a ballast in continuous operation is ten years and that fluorescent lighting has now been with us for over thirty years it is reasonable to expect that since a ten-hour working day is typical the rate of failure of ballasts will accelerate in the future. Fortunately, the vast majority of ballasts end their life with no dangerous consequences, either by blowing a fuse or by going open circuit. Nevertheless, where it is felt that there is need to increase safety margins in existing installations spacers and/or cut-outs may be applied.

Conclusion

A great deal of work is being done, in which Thorn Lighting plays its part, to encourage the harmonisation of national standards with the object of producing truly international ones. The immediate aim, which has already reached an advanced state, is to achieve completely unified standards in Europe leading to the adoption of a single European approval mark instead of the present national ones, and it is hoped that once this has been achieved the process will spread until a world-wide system is established. Such standards can do nothing but good, simplifying manufacture and marketing and hence encouraging world trade. The United Kingdom has long had a tradition of voluntary acceptance of standards and we have much to offer our new partners in the Common Market.

metal halide lamps for colour printing

by A L Salway MSc(Eng) *and* E J G Beeson MIIlumES MBK&TS

Even the most casual reader of the printed page must have noticed the increasing use of colour printing. Newspapers nowadays regularly carry coloured advertisements; magazines and catalogues rely on accurate colour reproduction for their effects. Colour printing, in fact, is big business.

The preparation and printing of colour features is a complicated process, beyond the scope of a short article such as this, but briefly it consists of taking a photographic negative of the required subject matter and then placing it in contact with a specially coated metal plate in a printing-down frame. This frame consists of a table top covered by a glass sheet, the negative and plate being kept in close contact by a vacuum introduced between the table top and the glass plate. The combination is irradiated by ultra-violet (u.v.) and the plate is then developed in appropriate chemicals which have the effect of etching those parts obscured by the dark parts of the negative during exposure.

Traditionally the source of ultra-violet has been the carbon arc. The main criterion for the lamp was the provision of ultra-violet of appropriate wavelength, particularly in the near visible u.v. range, to match the coating material of the plate. The carbon arc is not ideal: it is messy, not particularly stable, requires constant attention, and its running costs are by no means negligible. From time to time other sources have been used, such as high pressure mercury and pulsed xenon lamps, each of which has its merits, but the xenon lamp is expensive in the control gear necessary to run it.

Most sensitive plates and sensitised coatings depend upon energy emitted in the ultra-violet region and are comparatively insensitive to other frequencies so that they can be used in subdued daylight or in an artificially lit room. Light sources used for photo-printing must therefore provide the greatest possible output in the spectral sensitivity band of the materials being exposed in order to keep exposures reasonably short.

Requirements of the light source

To compare and appraise different light sources the following considerations must be taken into account:

a) Most of the radiated energy must fall into or match the spectral sensitivity of the material;

b) The lamp should preferably be able to be switched on or off to make an exposure;

c) In most instances the light should be a point source. This gives a sharp image and prevents undercutting (Figure 1) which can occur where a number of light sources are 'banked' to give even illumination. In some letterpress processes a large diffuse source is desirable;

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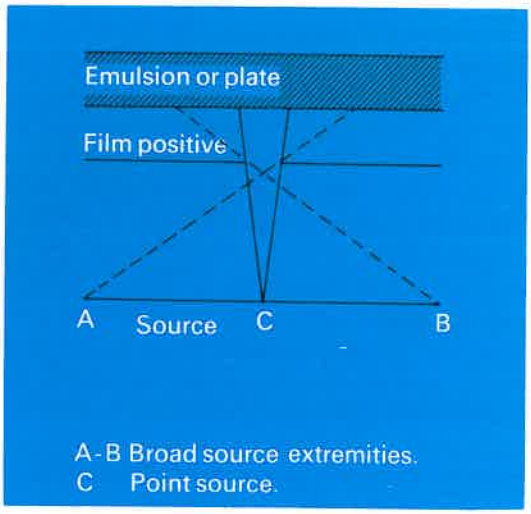

Figure 1

Degree of undercutting comparison for broad and point sources.

d) The lamp ideally should not emit erythemal-producing radiation or generate any toxic ozone;
e) Lamp life should be reasonably long and compatible with the economics of the process;
f) The infra-red content given by the light source should be minimal to prevent absorption and expansion of photographic materials particularly when these have to be brought into register with colour processes.

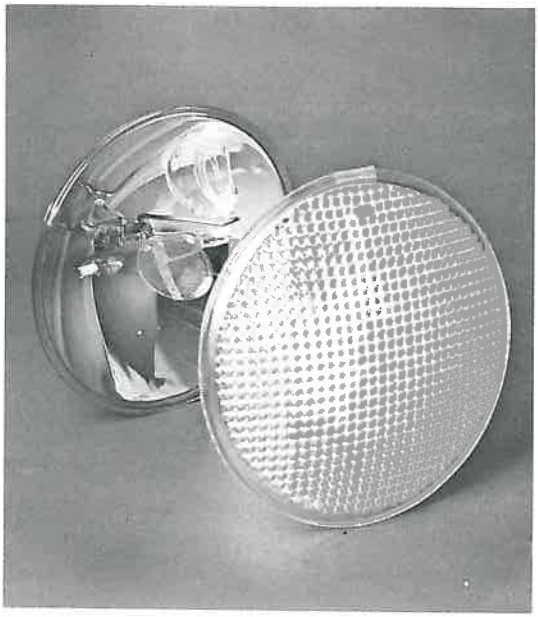

Figure 2 MBI PAR 64 with front glass removed to show arc tube.

Types of light source

The carbon arc and the mercury vapour lamp are already being rapidly replaced by other discharge sources for a number of reasons:

a) Higher actinic sources have been developed which are more selective in their radiated output;
b) Some discharge sources, although less actinic, can be switched on and off to make an exposure;
c) More powerful lamps approaching a point source to simulate the carbon arc offer cleanliness in operation as well as speed.

Lamps used in colour printing cover a wide area of application and are used not only in reprographic plate making but also for etch resists, letterpress, colour proofing, diazo, carbon tissue and other materials which are sensitive in the longer wave ultra-violet from 320nm to 460nm. (A nanometer is a wavelength of one millionth (10^{-6}) of a millimetre). The fluorescent tube is widely used for photo-copying, particularly in producing the final copy, and has the advantage of producing pure u.v. almost without heat. It has however a low total output and a number must be used with the consequent problem of light undercutting. The pulsed xenon lamp, because it can be switched on and off has been developed in high powers; it has been applied to many processes and is excellent for colour work since its spectrum is well balanced and constant in colour quality.

Some years ago Thorn introduced the Kolorarc lamp in which, by adding metal iodides and other halides as well as mercury to the arc tube, it was possible considerably to improve the colour quality of the lamp. This gave Thorn Lighting's Leicester development engineers the opportunity of taking a look at the possibility of developing a u.v. source for photoprinting purposes. By varying the additives within the arc tube, a technique was developed to produce sources with peak energy in the 400/420nm region.

A linear 1200W MBIL lamp was first introduced and tests were arranged in conjunction with equipment manufacturers and users. Results were more than promising. Agfa Gevaert, producers of coating materials known as Gevaproof, found the lamp so satisfactory that they now recommend the use of the Thorn 1200W MBIL in their Gevaproof process. A number of large printers, particularly in the Leeds area, have also converted their equipment from carbon arcs to the 1200W MBIL lamp.

Although highly successful, the 1200W MBIL lamp is not ideal for all circumstances. For the small printing frame it is too big, and it is far from a point source so that undercutting may result. Further, in conversion of old equipment the user had to tailor-make his own reflectors to suit his particular circumstances. It was therefore decided to introduce a 400W version of the lamp enclosed in a sealed beam envelope of similar size to the 1kW CSI sealed beam stadium lighting lamp.

By enclosing the metal halide lamp arc tube in a sealed beam reflector with a front refractor a unique ultra-violet lamp is produced (Figure 2) which offers a number of advantages. As the internally

aluminised reflector is enclosed in an inert atmosphere no deterioration of its surface occurs; the lamp is accurately pre-focused in its reflector which, with the refractor, produces an elliptical beam to give a high degree of uniformity over rectangular printing frames. The hard-glass outer envelope filters out any erythemal-producing radiation and no toxic ozone is generated. It is possible to produce reasonably uniform radiation over a rectangular area 24in x 20in, which is an average size smaller printing frame, with the lamp suspended at approximately 30in from the frame. The lamp is designed to operate at 400 watts from a commercial ballast with a starting aid from normal 240V a.c. supplies and takes less than three amps. The run-up time from switch-on is under two minutes and restrike time, dependent on the amount of ventilation, is around 7-10 minutes. Some of the more important lamp and circuit characteristics are summarised in Table 1.

Results have been more than satisfactory and show an average increase in printing speeds – watt for watt – of some eight times when compared with other lamp sources. A number of equipment manufacturers are introducing the lamp into their new designs. The first is Torr of Silverstone who already market printing-down frames incorporating either single or twin 400W sealed beam units (Figure 3).

Supply voltage	220–240V
Lamp watts	400W
Arc volts	105V
Arc current	4.4A
Supply p.f.	0.9 p.f (240V)
Supply current	2.2A
Diameter	205mm (8in)
Overall depth	110mm (4.375in)
Run up time	1½–2 min
Re-strike time	7–10 min (dependent on ventilation)
Life	1 000 hours nominal
Operating position	Any, provided arc tube is horizontal

Table 1 Lamp and circuit characteristics.

Figure 3

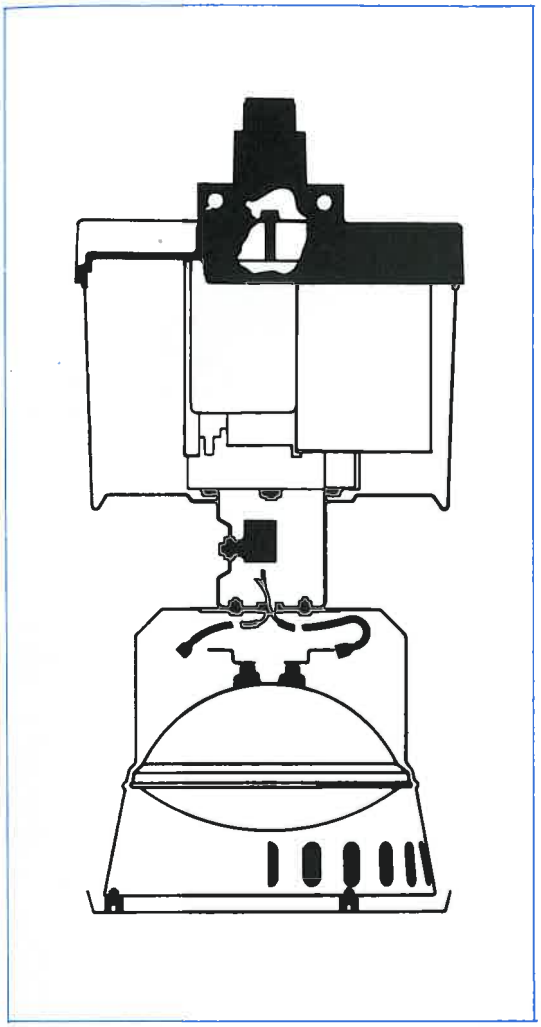

Figure 4

Figure 5

A number of printers both large and small use printing-down frames operated from separately mounted carbon arc lamps. To make simple conversions of these machines it is necessary to provide a complete package deal which can be offered as a single replacement to the carbon arc.

Existing frames where the light-source is accommodated in the base can easily be converted to take this lamp. For bench-top types the Graph-X fitting, a simple suspended unit comprising a control gear and starter compartment and a lamp housing with a magnetically held shutter lid, offers ready conversion (Figures 4 and 5).

The results obtained from practical experience in a number of rapidly growing applications are summarised in Table 2.

Conclusion

The Graph-X lamp not only provides a source for the major printing processes but is also meeting the requirements of the smaller printer. This application of u.v. for printing processes is indicative of the growing interest in u.v. sources for wider fields which is engaging the attention of Thorn Lighting's Research and Development Laboratories.

Material	Light source	Exposure time	Gain
Ammonium bichromate emulsion (Deep etch)	45 amp carbon arc (approx 2¼ kW)	8 min	
	400W Graph X	9 min	5X
Silk Screen	50 amp carbon arc (approx 2½ kW)	6 min	
	400W Graph-X	5 min	7½X
Diazo coated aluminium	1 kW mercury	4 min	
	400W Graph-X	1.25 min	8X
Photo-resists	500W mercury	25 min	
	400W Graph-X	3 min	10X

Table 2

avonbank - a footnote

from Lighting Research and Technology volume 5, no. 2 1973

The controlled environment at Avonbank, the South Western Electricity Board's offices at Bristol, was described in *Lighting Journal* no. 7. The offices have now been in use for over two years and were the subject of a paper read to a joint meeting of the IES and the Building Services Engineering Society by Ian Crichton and Mark Wood-Robinson last November.

One of the most interesting points that came out was the reaction of people working in the Avonbank offices to the new conditions. Most of these people had previously been working in smaller conventional offices throughout Bristol, and, knowing that they were to be moved to Avonbank, the SWEB made a survey of their attitudes towards various environmental factors at their places of work before they moved. The same questionnaire was put to them three or four months after moving to Avonbank. Some of the results are shown here. They speak for themselves, although Mr Wood-Robinson remarks that you can never expect to please all of the people all of the time.

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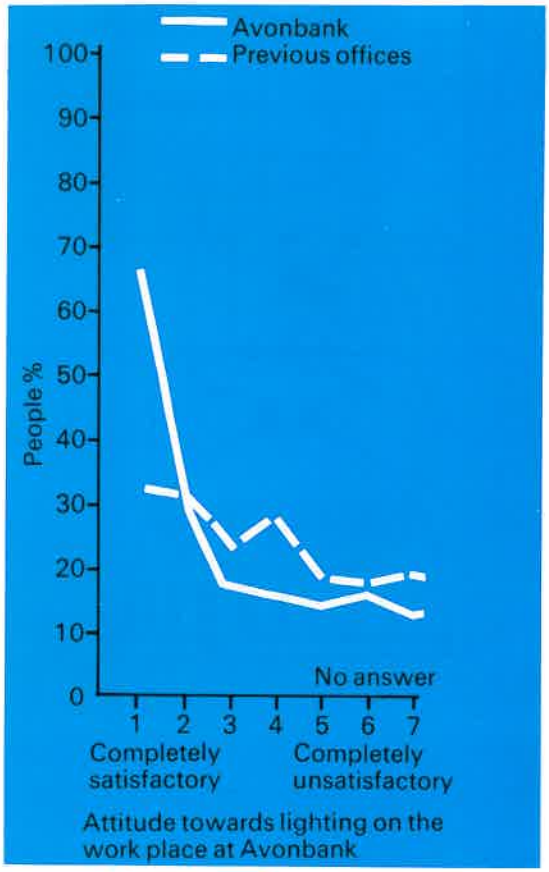
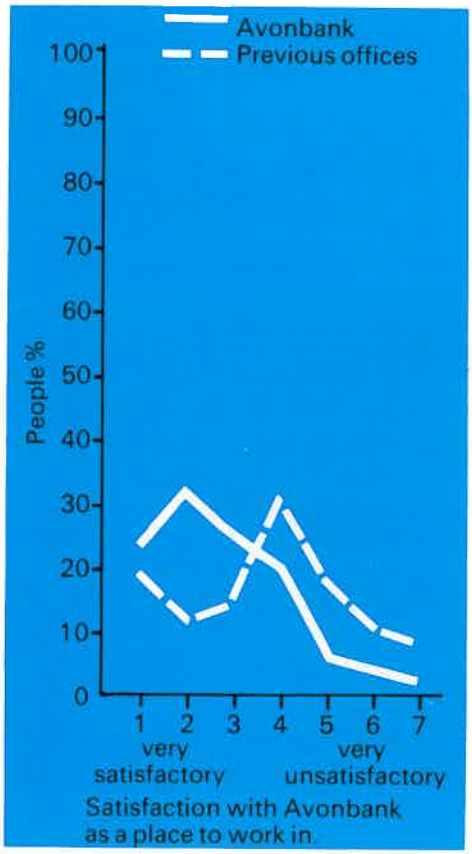
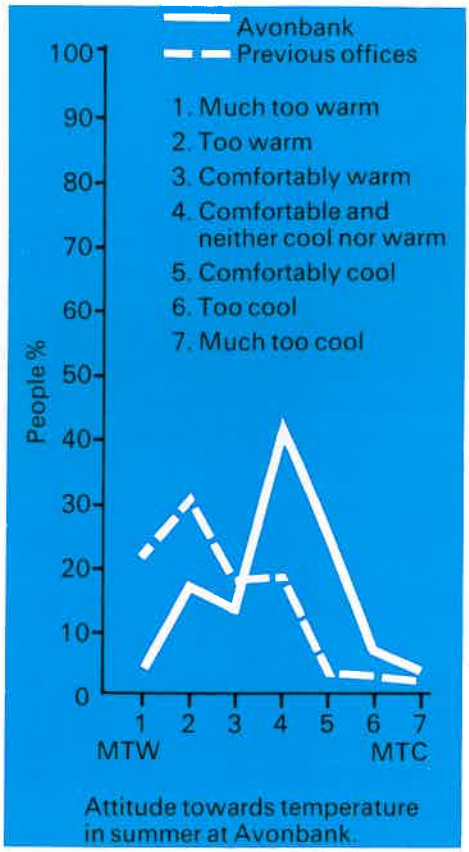


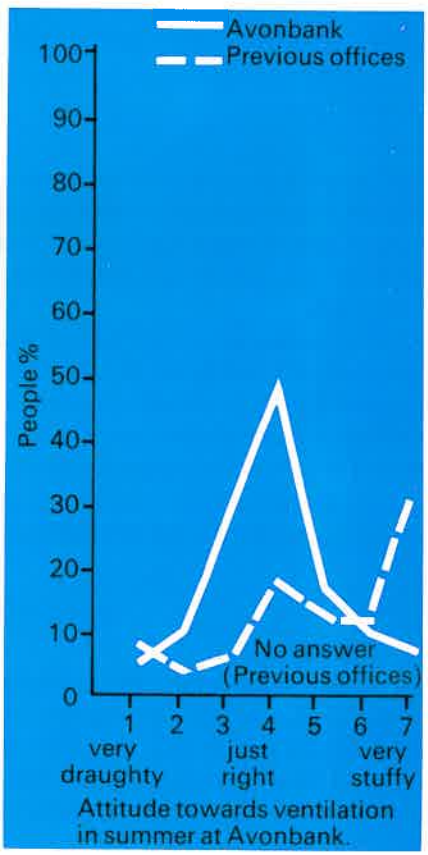
Attitude towards lighting on the work place at Avonbank



Satisfaction with Avonbank as a place to work in



Attitude towards temperature in summer at Avonbank.



Attitude towards ventilation in summer at Avonbank.

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